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APPLICATION OF NEW MAKE-UPS OF SURFACTANTS FOR FOAM PRODUCTION

In this country oil extraction has been marked by decrease for last 15–20 years. Reserves increment is only due to new deposits which are difficult to recover. A shift to developing difficult-to-recover deposits demands another approach to initial opening-up of a productive layer. Abnormal formation pressure, salt section, permafrost and others are these difficult geological factors.

Drilling practice shows that zones with abnormally low pressure (ZALP) have been found less often than zones with abnormally high pressure (ZAHP). Nevertheless, ZALP have been registered in many oil producing areas in the course of drilling of oil and gas wells.

The analysis of the statistics on formation pressure of productive layers [4] in the deposits of the Perm region, Western and Eastern Siberia shows that in most cases (about 70%) the initial coefficient of anomaly is as great as 0.94–0.99 and only in some cases it makes 0.75 or less. Deposits with ZALP are primary located in Western Siberia.

ZALP can be caused by non-observance of modes of formation pressure maintenance during oil-and-gas-field operations. Lifting of considerable quantities of pore fluids can lead to a sharp decrease in formation pressure. Drainage during oil-and-gas-field operations can reduce the pressure of pore fluids if great pressure of water can't compensate this reduction; often as a result of it productive layers are compacted [6]. It is possible to give dynamics of formation pressure of deposits of Kogalymsky region (Western Siberia) as an example. According to the results of the analysis of this extraction parameter during oil-and-gas-field operations (for last 20 years) there is a decrease in formation pressure up to 12–50% (Fig. 1) if compared and contrasted with initial formation pressure [1, 4].

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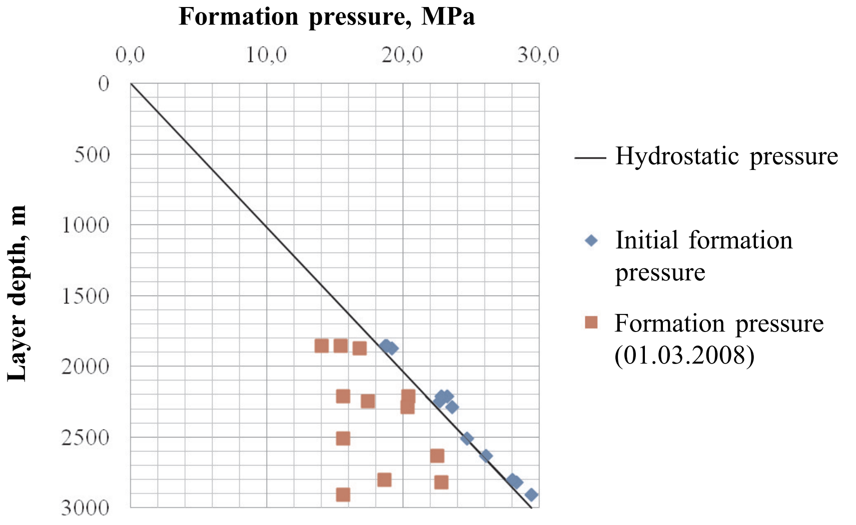

Fig. 1. Dynamics of decrease in formation pressure of a productive layer during oil-and-gas-field operations in Kogalymsky region (Western Siberia)

It is difficult to forecast a decrease in formation pressure, as it depends on a considerable number of factors, such as a condition of a productive layer (a physical-mechanical condition of a formation, initial formation pressure and temperatures, etc.), a pore fluid (its structure and characteristics), modes and extraction systems. Therefore, a decrease in pressure is of varying intensity in each deposit. From the point of view of well drilling it is possible to influence it by application of low impact technologies of opening-up.

The analysis of a current state of theory and practice of primary opening-up of a productive layer with ZALP with using lightened drilling fluids (PermNIPIneft, KogalymNIPIneft, NPO Burenie, etc.) allows to draw a conclusion that one of the most promising approaches is the use of liquid-gas mixtures (LGM) for drilling of wells.

Mixtures of anionic and nonionic surfactants have been used in domestic drilling practice with liquid-gas mixtures. Some amphiprotic surfactants, for example, lauryl murestil betaine, kokoamidopropil betaine, etc., with anionic surfactants and NaCl are foam boosters and viscosifiers. It has been established that mixtures possess higher carrying-out ability than a single surfactant, due to complex influence of various active components.

Summing up requirements for the make-up of surfactants, it is possible to draw a conclusion that foam reacting substance composition should include a foam-promoter and a collecting agent; organic polymer to increase foam stability; a reagent to increase a mixture structure and its carrying-out ability; a reagent to soften water hardness; a hydrophobizating reagent [3].

Among a large quantity of reagents used in oil and gas industry, it is possible to state the following components of foam reacting substances:

- sulfonol, lauryl sodium sulfate, laureth sodium sulfate, OP-7, OP-10, etc. are used as foam-promoters and collecting agents;
- sulfate cellulose (SEC), carboxy methyl cellulose (CMC), methyl cellulose (MC), sulfacell B, etc. are stabilizing agents;

– bentonite, calcium hydroxide, katapin-K are structure forming agents;
– caustic soda, soda ash, sodium hydrocarbonate, calcium hydroxide, sodium orthophosphate are used to soften water hardness;
– katapin-K, hydrophobizating organosilicon liquids (HOL), liquid hydrophobizating Osnova GS, a sintal-BT, etc. are used as water-repellent admixtures.

A variety of make-ups, properties, areas and conditions of the use of surfactants makes their estimation rather difficult. The most accurate are physical and chemical parameters (adsorption, an interfacial angle, surface activity, etc.). However, some problems arise when these parameters are used for rating of mixtures of surfactants (including synthetic surfactants of commercial production). Nevertheless, only these parameters can *a priori* be used to choose certain synthetic surfactants for multipurpose reagents [5]. Lathering power (by Ross-Majls) and kinetics of destruction of liquid-gas mixtures are assessed by a technique described in [2]. In this work the received results are correlated with the results for single-agent surfactants.

Experiments were carried out in an inter-department laboratory of hydrogeochemistry, at the depertment of mineralogy, crystallography and petrography of SPMI, in JSC "Himgortechnologia" and in VNIIGhirov. A binary mixture consisting of nonionic foaming agents was investigated: synthanol ACSE-12 and T-80, being a floatation agent.

Earlier each surfactant was used separately for liquid-gas mixtures [2, 7]. According to E.A. Ahmetshin and M.R. Mavljutov reagent T-80 improves greasing and antiwear properties of a clearing agent. So, while drilling of wells with water flush containing 0.8–1.2% of T-80, a decrease in wearing out of holders and cutting structures of roller-cutter bits, a growth of mechanical speed up to 35% and drilling rate per bit up to 25% have been observed. T-80 can be used as antifreezing additives, if necessary.

Research of the specified above binary structure of surfactants for liquid-gas drilling mixtures has been conducted. Some results of the research are given in Tables 1 and 2.

Table 1

Dependence of Lathering Ability on Concentration of Surfactants

Surfactants and their concentration in a solution [%]	Lathering ability of surfactants ($\times 10^{-3}$ m) in water of different hardness [mg ekv/l]			
	very soft (1.5)	soft (3.0)	medium lime (6.0)	lime (9.0)
Sulphonol NP-1 (0.2)	161.3	160.1	–	–
Sulphonol NP-1 (0.5)	171.4	169.2	–	–
ACSE-12 (0.2) + T-80 (0.1)	161.9	160.5	160.1	159.0
ACSE-12 (0.2) + T-80 (0.3)	172.5	171.8	171.1	170.6
ACSE-12 (0.2) + T-80 (0.5)	184.1	183.6	182.9	182.4
ACSE-12 (0.2) + T-80 (0.7)	195.8	193.2	191.9	191.3
ACSE-12 (0.3) + T-80 (0.5)	200.5	200.2	200.0	199.7
ACSE-12 (0.05) + T-80 (0.5)	121.3	120.5	119.0	118.1

Table 2

Kinetics of destruction liquid-gas mixtures containing fresh water

Surfactants and their concentration in a solution [%]	Foam lifting ($\times 10^{-3}$ m) for 30 sec	Height of a foam column of ($\times 10^{-3}$ m) during observation [sec]					
		300	600	900	1200	1500	1800
Sulphonol NP-1 (0.2)	5.5	5.5	5.4	5.2	5.1	5.0	4.8
Sulphonol NP-1 (0.5)	7.0	7.0	6.9	6.8	6.7	6.7	6.5
ACSE-12 (0.2) + T-80 (0.1)	7.5	7.5	7.5	7.5	7.4	7.3	7.1
ACSE-12 (0.2) + T-80 (0.7)	7.9	7.9	7.9	7.9	7.7	7.7	7.6

CONCLUSIONS

Binary surfactants of ACSE-12 (from 0.05% to 0.3%) + T-80 (from 0.1% to 0.5%) is recommended to be used for water-foam emulsions and aerated liquids, and of ACSE-12 (from 0.2% to 0.3%) + T-80 (from 0.5% to 0.7%), for aerated solutions and stable foam.

Suggested binary mixtures of surfactants (ACSE-12 + T-80), satisfying to the earlier stated technology requirements for different technical and geological conditions, preservation of the environment, allow to get grade liquid-gas mixtures, more effective than the widely used nowadays sulphonol NP-1.

It is necessary to say some other reagents with similar properties, which have not been used in oil and gas industry before, can be used as components for this solution.

In this connection, working out of structures of liquid-gas mixtures is important.

To solve the given problem, it is necessary to regulate the make-up and properties of LGM, the surfactants used in them, and to carry out some research of efficiency of various make-ups of surfactants under similar well conditions, and also to make an in-field check of the suggested recommendations and an estimation of their economic efficiency and ecological safety.

REFERENCES

[1] Babushkin E.V., Bakirov D.L.: *Razrabotka i opyt primeneniya oblegchennyh polymi mikrosferami burovyh rastvorov na mestorozhdeniyah Kogalymskogo regiona*. Novye tehnologii i bezopasnost’ pri burenii neftyanyh i gazovyh skvazhin: Materialy Vserossiiskoi nauchno-prakticheskoi konferencii, Ufa, 27–28 maya 2009.

[2] Kudryashov B.B., Kirsanov A.I.: *Burenie skvazhin s primeneniem vozduha*. Nedra, Moskva 1990.

[3] Muraev Yu.D.: *Gazozhidkostnye sistemy v burovyh rabotah*. Sankt-Peterburgskii gosudarstvennyi gornyi institut (tehnicheskii universitet), SPb 2004.

[4] Maksimova S.P. (Eds): *Neftyanye i gazovye mestorozhdeniya SSSR: Spravochnik v dvuh knigah*. Nedra, Moskva 1987.

[5] Sherstnev N.M., Gurvich L.M., Bulina I.G.: *Primenenie kompozicii PAV pri ekspluatacii skvazhin*. Nedra, Moskva 1988.

[6] Fertl' U.H.: *Anomal'nye plastovye davleniya*. Nedra, Moskva 1980.

[7] Yakovlev A.A.: *Gazozhidkostnye promyvochnye i tamponazhnye smesi (kompleksnaya tehnologiya bureniya i krepleniya skvazhin)*. Sankt-Petersburgskii gosudarstvennyi gornyi institut (tehnicheskii unversitet), SPb 2000.