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4. **Babiyuk, G.V.**, Litvinskiy, G.G., Stel'makh, V.I. (1996). Patent of Ukraine No. 10567 A. Retrieved from http://uapatents.com/2-10567-sposib-rozporu-ramnogo-piddatlivogo-kriplennya.html?do=download

5. **Babiyuk, G.V.**, Babiyuk, G.G., Toptun, N.I. (2001). Patent of Ukraine No. 35719 A. Retrieved from http://uapatents.com/7-35719-sposib-montazhu-ramnogo-piddatlivogo-kriplennya.html?do=download

6. **Babiyuk, G.V.** (2009). Patent of Ukraine No. 45127. Retrieved from http://uapatents.com/4-45127-adaptivne-ramne-kriplennya-girnichikh-virobok.html?do=download

7. **Litvinsky, G.G.**, Fesenko, E.V. (2012). Issledovaniye rabotosposobnosti shakhtnoy krepi s pozitsiy printsipov ravnoprochnosti. Forum hirnykiv-2012: Vol.2 (pp. 7-16). Natsionalʹnyy hirnychyy universytet.

8. **Litvinsky, G.G.**, Fesenko, E.V., Emetz, E.V. (2011). Raschet krepi gornykh vyrabotok na EVM : ucheb. posobiye. Alchevsk, Ukraine: DonDTU.

9. **Barchunova, T.N.** (2010). Koeffitsiyenty posteli, prinyatyye pri raschete go-rizontal'no nagruzhennoy svai-kolonny s ushireniyem. Visnyk Odesʹkoyi derzhavnoyi akademiyi budivnytstva ta arkhitektury, 38, 35-41.

COMPLEX APPROACH TO RESEARCH AND SELECTION OF HYDROCARBON SOLVENTS FOR ASPHALTENE-RESIN-PARAFFIN-HYDRATE DEPOSITS CONTROL

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Abstract

The article deals with the chemical methods of combating asphalt-resin-paraffin-hydrate deposits, in particular, the use of solvents. The influence of different chemicals on the dissolution of hydrates in the laboratory installation at different temperature-bar modes was carried out: the temperature varied discretely from -10 to + 40 ° C, the pressure from 0 to 10 MPa. To study the effect of hydrocarbon solvents on the process of removal of hydrate formations, we used the methods of regression analysis and mathematical planning of the experiment – simplex-lattice planning. The G-optimality criterion of the plan, including 22 experiments, was used. The measurement results are shown in the diagrams for each solvent separately. The obtained data made it possible to substantiate a priori the choice of the optimal variant of the use of chemical reagents for complete dissolution and removal of hydrate formations from the surface of the downhole equipment. Analysis of the data shows that the highest solubility and efficiency for removal from the surface of the wellbore equipment of paraffin hydrate deposits are characterized by the solvents butyl cellosolve and ethylacetat, which are recommended for widespread use in the industries of Ukraine. An important fact is that the consumption of the proposed solvents for one well-operation is no more than 4 m^3, which is 2-3 times less than other domestic and foreign analogues. The use of new solvents also allows more than 2-3 times to increase the intercurrent well period, which reduces the cost of production.

Keywords: asphaltene-resin-paraffin-hydrate deposits, dissolvant, downhole equipment, chemical reagent, butyl cellosolve, ethylacetat.

Introduction. Since asphaltene-resin-paraffin and hydrates formations are deposited on the surface of the dowmhole equipment (casing and pumping tubes, pump housings, pump rods) it is necessary to use a universal reagent that would allow all types of such deposits to be dissolved and removed. In order to select such a chemical, we have conducted laboratory and industrial studies.

Formulation of the problem. The above data show that the most effective, economical and technologically simple to use are chemical methods, in particular, the use of solvents. It is known [1, 2, 6, 7] that the use of hydrocarbon solvents is one of the main methods of protecting wells and oilfield terrestrial communications from asphaltene-resin-paraffin deposits. The whole operational period of the wells, complicated by asphaltene-resin-paraffin-hydrate deposits, depending on the magnitude of the well cleaning interval without the use of chemical reagents can be divided into four groups [3-5]:

1 – well cleaning interval up to 10 days;
2 – well cleaning interval from 10 to 20 days;
3 – well cleaning interval from 20 to 30 days;
4 – well cleaning interval more than 30 days.

If in wells 1 and 2 groups the use of chemical reagents should be combined in a certain sequence when cleaning the underground equipment with reagents and dosage of inhibitors of paraffin deposits, then in the wells 3 and 4 groups is the most effective use of hydrocarbon solvents.

Presenting main material. First, on the laboratory installation, the schematic diagram of which is shown in fig. 1, studies of the effect of different types of chemicals on the dissolution of hydrates as the most soluble to remove. The experiments were carried out in the following temperature-bar modes: the temperature varied discretely from -10 to + 40 ° C, the pressure from 0 to 10 MPa, which most closely corresponds to the real regimes of the sheltered space of oil wells. In this case, the experiments were set up as follows: if the temperature was constant, for example, 0 ° C, the pressure discretely varied from 0 to 10 MPa and vice versa, at constant (fixed) pressure the temperature changed.

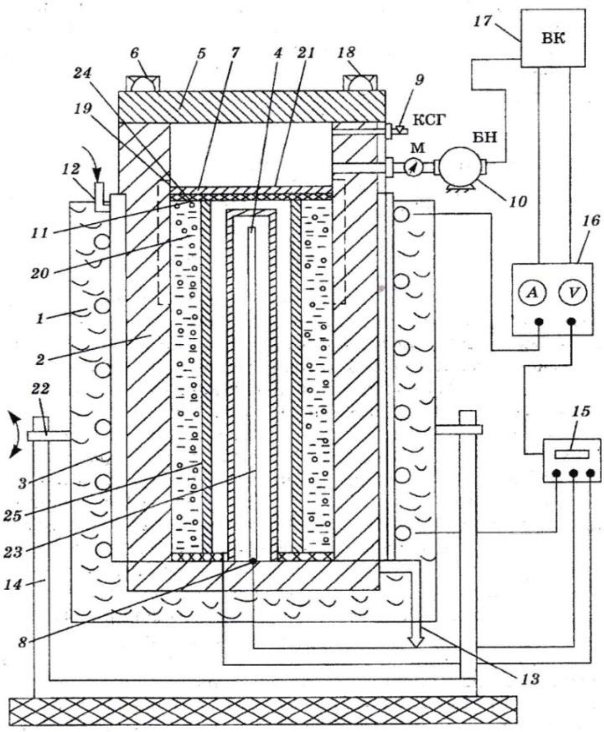

Fig. 1. Schematic diagram of the experimental installation:
1 – furnace; *2* - chamber of cylindrical shape; *3* – cooling jacket; *4* – tube; *5* – means of cover; *6* – squeeze bolts; *7* – insulation (textolite) gasket; *8*, *15* – electronic potentiometers; *9* – nipple; *10* – pump; *11* – grooves; *12* – special device; *13* – crane; *14* – frame; *16* – autotransformer with an ammeter and a voltmeter; *17* – computational complex; *18* – pulse tube; *19* – groove; *20* – reservoir water and gas fluid; *21*, *25* – upper and lower walls; *22* – pins; *23* – electric heater; *24* – inner lid

Samples of tubing 1.4 m long, 72 mm in diameter, type of steel 36G2S and a reservoir-oil mixture were used as objects of study. As reagents used butyl cellosolve, ethylacetat, SNPH-7p and SNPH-7p-14, ethylbenzene and butylbenzene fractions. Chemical reagents were poured into the chamber in the amount of 1, 2, 3, 4 and 5 liters, based on the calculation of 10 - 50 liters per 1 m^3 of internal volume of the well. To study the effect of hydrocarbon solvents on the process of removal of hydrate formations from the wells, quantitative description of this effect and a significant reduction in the number of experiments, it is rational to use methods of regression analysis and mathematical planning of the experiment - simplex-lattice planning. Because specific hydrocarbon solvents cannot be implemented in the entire study area, they are subject to additional restrictions. As a result, the planning area becomes complex. In this area, it is advisable to use the G-optimality criterion of the plan [8], which includes 22 experiments and allows to minimize the maximum variance of the predicted values (fig. 2). The addition of a G-optimal plan ensures that there are no points in the planning area where the accuracy of the response surface estimation is not too low. The synthesis of the plan was implemented by numerous methods at the «Hewlett-Packard» computer.

According to the requirements of the plan, hydrocarbon solvents (22 brands of each system) were selected. The content of each solvent varied from 0 to 100%, while the total content of the three solvents remained unchanged and was 100%. As a result of the experiments, fifth order multiple regression equations (regression coefficients significant at the level) were constructed, which were used to construct the level lines on the triple diagrams. The adequacy of the obtained regression equations was tested using the Fisher F-test [9] at 5% significance level. The values of the correlation coefficients r=0.97-0.99, which indicates a good fit of the experimental data to the given regression equations and the possibility of using them as formal computational models.

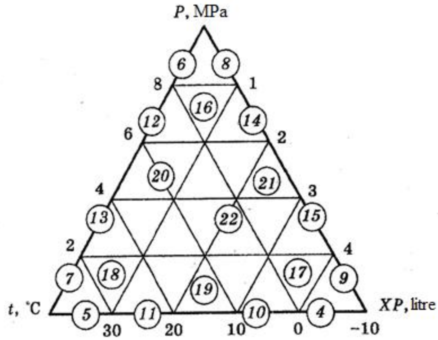

Fig. 2. Triple diagram experiment plan

The duration of the experiments was 12 hours. At the end of each experiment, the contents of the chamber were poured into the tank, and the sample tubing tubing and the inner surface of the chamber were carefully cleared of deposits, which were subsequently weighed on electronic scales to an accuracy of 0.001 g. The measurement results are shown in fig. 3-8.

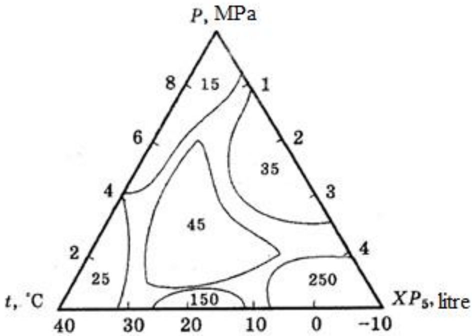

Fig. 3. The mutual influence of temperature, pressure and amount of chemical reagent ethylbenzene fraction on the value hydrate formation (g)

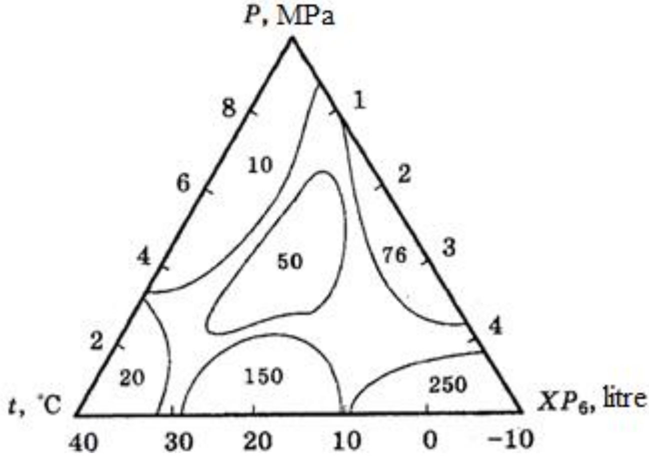

Fig. 4. The mutual influence of temperature, pressure and amount of chemical reagent of butylbenzene fraction on the value hydrate formation (g)

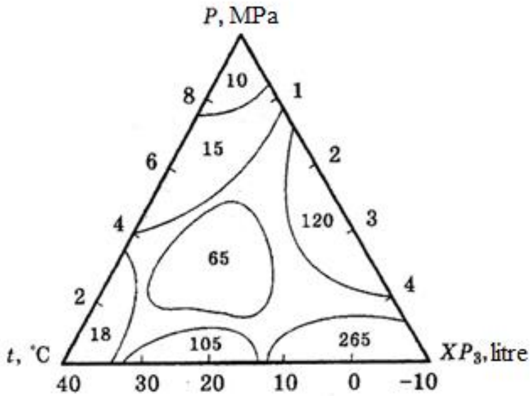

Fig. 5. The mutual influence of temperature, pressure and amount of chemical reagent SNPH-7p on the value hydrate formation (g)

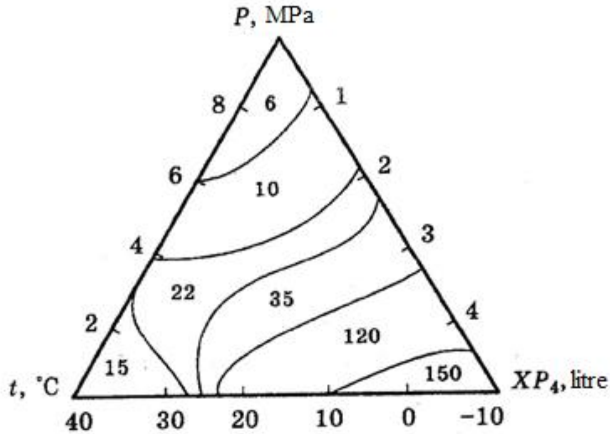

Fig. 6. The mutual influence of temperature, pressure and amount of the chemical reagent SNPH-7p-14 on the value hydrate formation (g)

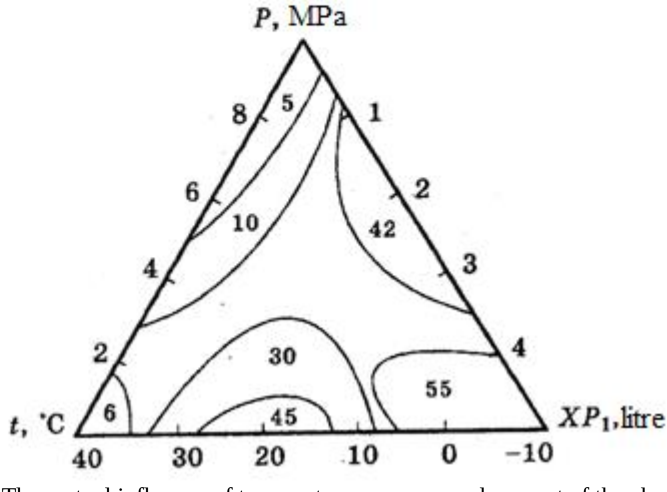

Fig. 7. The mutual influence of temperature, pressure and amount of the chemical reagent butyl cellosolve on the value hydrate formation (g)

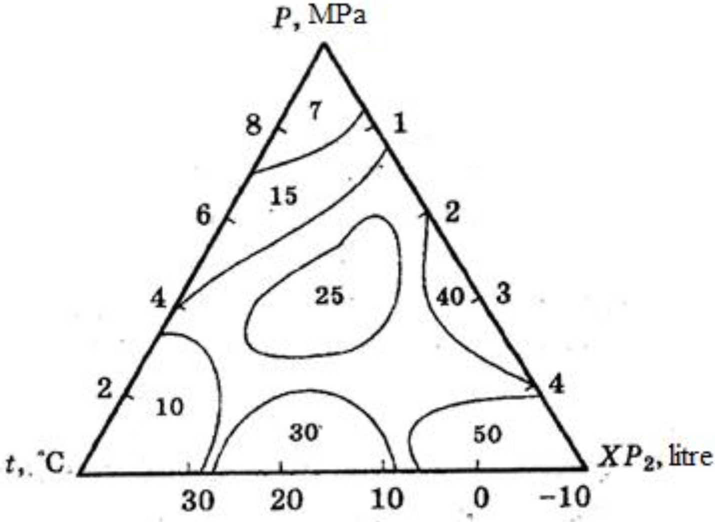

Fig. 8. The reciprocal effect of the temperature, pressure and amount of the ethylacetat chemical reagent on the value hydrate formation (g)

The analysis of the obtained data shows that the best dissolving properties have butyl cellosolve and ethylacetat in all investigated thermobaric modes. Their solubility reaches about 90-95 %. A fairly high solubility (40-60 %) showed composite hydrocarbon solvents SNPH-7p-14 and SNPH-7p.

Widely used in the artisanal chemicals – ethylbenzene and butylbenzene fractions – are characterized by very low solubility (an average of 15-20 %) hydration, although, as is known from practice, they dissolve asphaltene-resin-paraffin deposits quite well [10]. The obtained data made it possible to substantiate a priori the choice of the optimal variant of the use of chemical reagents for the complete dissolution and removal of hydrate formations from the surface of the downhole equipment, in particular, the injection into the well (inside the tubing and sheltered space) of solvents – butyl cellosolve and ethylacetat in the amount of 2-4 liters per 1 m^3 of well volume, ie an average of 2-4 m^3 per well depth of 1.5-2.5 km.

Conclusions.

1. Developed information-measuring system and equipment, which allow to fully approximate the conditions and modes of hydra-

tion formation to the real well processes and characteristics, which makes it possible to investigate hydration formation with a wide probability in a wide range of changes of temperature and pressure.

2. The statistical results of the experiments obtained with the help of the information-measuring system made it possible to determine the conditions required for hydration in the temperature range from -15 to +60 °C and pressures from 0 to 60 MPa, which are well confirmed by thermodynamic calculations of phase equilibria in the annulus of the well space known from the literature.

3. The influence of chemical reagents on the dissolution of paraffin hydrate deposits in a wide range of changes in temperatures and pressures was investigated using an information-measuring system using the method of mathematical planning of experiments. It is established that the most soluble and purifying ability is characterized by the chemical reagent butyl cellosolve and ethylacetat, which are recommended for widespread use in the industries of Ukraine.

The use of new solvents allows more than 2-3 times to increase the interworking period of the well, 5-10 times to increase the productivity of the well and up to 90 % to restore its initial properties.

References

[1]. **Troyanovskij Yu.V.** Osobennosti parafinizaczii promy`slovogo oborudovaniya i razrabotka mer po bor`be s otlozheniyami v usloviyakh mestorozhdenij Zapadnoj Sibiri: Avtoref. diss. kand. tekhn, nauk.- Tyumen`, 1971.

[2]. **Tronov V.P.** Mekhanizm obrazovaniya smoloparofinovy`kh otlozhenij i bor`ba s nimi.- M.: Nedra, 1970.-200 s.

[3]. Usloviya i zony` gidratoobrazovaniya v zatrubnom prostranstve neftyanoj skvazhiny`/ **M.G.Vyatchinin, N.K.Pravednikov, O.Yu.Batalin i dr**. // Neftyanoe khozyajstvo.- 1998.-t # 2.- S. 56-57.

[4]. Zakonomernosti gidratoobrazovaniya v zatrubnom prostranstve neftyanoj skvazhiny`/ **M.G.Vyatchinin, N.K.Pravednikov, O.Yu.Batalin i dr.** // Neftyanoe khozyajstvo.- 2001.- № 4.- S. 54-57.

[5]. **Vyatchinin M.G., Batalin O.Yu., Shhepkina N.E.** Opredelenie rezhimov i zon gidratoobrazovaniya v neftyany`kh skvazhinakh // Neftyanoe khozyajstvo.- 2000.- № 7.- S. 38-44.

[6]. **Khoroshilov V.A., Semin V.I.** Preduprezhdenie gidratoobrazovaniya pri doby`che nefti / Prirodny`e i tekhnogenny`e gazovy`e gidraty`.- M.: Nedra, 1990.- 220 s.

[7]. **Maganov R., Vakhitov G., Batalin O**. Optimal`naya tekhnologiya bor`by` s gidratoparafinovy`mi otlozheniyami // Neft` Rossii.- 2000.- # Z,- S. 96-99.

[8]. **Kasatkin O.G.** K voprosu postroeniya G-optimal`ny`kh planov na simplekse / Primenenie matematicheskikh metodov dlya issledovaniya mnogokomponentny`kh sistem.- M., 1974.- S. 64-69.

[9].https://www.itl.nist.gov/div898/handbook/eda/section3/eda359.htm

[10]. **Svetliczkij V.M., Demchenko P.N., Zariczkij B.V.**//Problemy` uvelicheniya proizvoditel`nosti skvazhin. - Kiev: Vid. Palivoda A.V., 2002. - 228s .

[11]. Code of Practice for Pipelines - Part 1 (2004) Steel Pipelines on Land, PD 41 8010, British Standards Institution, 44 p.

[12]. **Makarenko V.D., B.O. Korobko & Yu.L. Vynnykov** (2018) Innovatsiini materialy ta tekhnolohii v naftohazovii haluzi: monohrafiia . Nizhyn: NDU im. M. Hoholia. 233p.

INVESTIGATION OF THE OSCILLATIONS AMPLITUDES BASES AND FOUNDATIONS OF THE FORMING MACHINE

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Abstract

Dynamic load equipment is a source of waves that propagate in the ground and affect nearby buildings and structures. Objects with equipment that are sensitive to vibration and operating personnel are not infrequently exposed to vibrations that do not rarely exceed the values set by regulatory documents. The foundations of molding machines from the influence of dynamic loads were studied experimentally, taking into account damage to the foundations. Also, the magnitude of the amplitude was influenced by the above mentioned soil properties, which arose during their operation, the physical and mechanical characteristics of the soil of the bearing layer, as well as the underlying layers.

To measure the amplitudes of oscillations and sediments of the foundations of the molding machines used modern measuring equipment It is determined that the amplitude of oscillation of the base under study when the machine is almost 2.3 times higher than acceptable. And at work of all machines at the same time the amplitude of oscillations of a certain foundation 13.7 times exceeds the allowable