Effectiveness of demulsifiers for the destruction of highly mineralized water-oil emulsions of the Srednebotuobinsky oil and gas condensate field

Maria Ivanova[1,*], *Kirill* Tomskii[1]

[1]Polytechnic Institute (branch) of the North-Eastern Federal University named after M.K. Ammosov in Mirny, 5, build 1, Tikhonova st., 678171, Mirny, Republic of Sakha (Yakutia), Russia

Abstract. One of the most serious problems of field oil treatment at the Srednebotuobinsky oil and gas condensate field is an abnormally high content of chloride salts, reaching 350 thousand mg / dm^3. The high content of chloride salts significantly complicates the preparation of oil and requires other approaches both in production and in the preparation of extracted raw materials. In this paper, the influence of the drilling fluid used in the Srednebotuobinsky oil and gas condensate field together with the most popular demulsifiers and the effect of acidity on the oil dehydration process are considered. To determine the compatibility of the drilling fluid with the formation water of the field, tests were conducted at various concentrations of the drilling fluid at temperatures. Based on the results of the data obtained, the optimal concentration of Flo-Pro NT drilling fluid from M-I Drilling Fluids Co and ANCO-2000 from ANCOR Drilling Fluids was determined at reservoir temperatures and oil treatment temperatures. Under the conditions selected above, the dynamics of desalination and dehydration of oil from the Srednebotuobinsky field were determined at various dosages of demulsifiers DMO 25126 and Dissolvan 13853 and at various acidities of the medium.

1 Introduction

Demulsifiers play an important role in the process of dehydration and desalting of oil, and have a great influence on the quality of the processed oil. Modern demulsifiers, as a rule, are composite and are a mixture of nonionic surfactants (surfactants) and solvents [1].

The supply of oil-water emulsions, complicated by the presence of various kinds of stabilizers, to the oil treatment unit (OTU) leads to a deterioration in the process of oil dehydration and desalination. Intermediate layers cease to act as a zone of active coalescence, as well as filtration of water droplets and mechanical impurities, which leads to the transition of emulsions to the category of stable ones [2-5].

Development of the Srednebotuobinskoye oil and gas condensate field in the Republic of Sakha (Yakutia) is complicated by the presence of abnormally highly mineralized

* Corresponding author: ims.06@mail.ru

formation waters. To date, the preparation of oil from this field is impossible without the use of technologies involving the use of various chemical reagents (demulsifiers).

From the data in Table 1, the oils of the Srednebotuobinskoye oil and gas condensate field can be characterized as oils of medium density, medium viscosity, paraffinic and highly resinous.

Table 1. The characteristics of oil from the Srednebotuobinskoye field.

Characteristic	Value
Density of oil,, ρ_4^{20}	870,8
Dynamic viscosity of oil emulsion, mPa · s	36,5
Water cut,% vol.	16
Sulfur content,% wt.	1,15
Resin content,% wt.	17,87
The content of solid paraffins,% wt.	1,91
Fractional composition of oil,% vol.	
up to 200^0C	18,47
up to 300^0C	38,45

The type of stabilizers for water-oil emulsions of the Srednebotuobinskoye field is asphaltene. Typically, emulsions formed by such oils are highly resistant to demulsifier attack.

The efficiency of using various demulsifiers in fields depends not only on natural stabilizers for water-in-oil emulsions, but also on the conditions of development and operation of the field. One of the possible reasons for the complication of the preparation process is the composition of the used drilling fluid in the well. Biopolymer-based drilling fluid systems are widely known today. One of the most popular and used drilling fluids in the Srednebotuobinskoye field is Flo-Pro NT from M-I Drilling Fluids Co and ANCO-2000 from ANCOR Drilling Fluids.

As a result of using the above type of drilling mud, systematic failures in oil preparation were recorded. At the same time, the production of wells was characterized by the formation of finely dispersed oil emulsions resistant to destruction. One of the reasons for the complication of oil preparation in the Srednebotuobinskoye field is the abnormally high content of chloride salts in the formation water, the content of which reaches 350 thousand mg / dm3 [6-8].

2 Materials and method

Some of the most effective reagents to date, DMO 25126 and Dissolvan 13853, were used to select the optimal conditions for oil treatment in the Srednebotuobinskoye field. , in conditions close to the real conditions of oil treatment (separation temperature, time factor, hydrodynamic characteristics, dosage, water cut).

2.1 Determination of compatibility of drilling fluid based on biopolymer Flo-Pro NT with formation water

To determine the compatibility of the drilling fluid based on the Flo-Pro NT biopolymer with formation water in the conditions of the Srednebotuobinskoye field, tests were carried

out at temperatures corresponding to the temperature at the inlet to oil treatment units, equal to 200C, and a temperature in reservoir conditions, equal to 120C.

In the first series of five test tubes, aqueous solutions of the Flo-Pro NT biopolymer with concentrations of 90, 70, 50, 30, 10 g / dm3 were prepared using formation water as a solvent. The resulting mixtures were kept for 3 hours at 20 ° C. In the second series, drilling fluids were prepared with concentrations of 90, 70, 50, 30, 10 g / dm3, while the resulting fluids were kept for 3 hours at reservoir temperature. In all tests, formation water without drilling mud was used as a reference sample.

2.2 Testing the demulsibility of DMO 25126 and Dissolvan 13853 in the presence of drilling mud

During further testing of demulsifiers, the water content in the sampled oil-water emulsion was determined by the Dean-Stark method according to GOST 2477-2014.

The preparation of solutions containing drilling mud with a concentration of 0.5%, 1.0%, 2.0% and 5.0% was carried out by mixing the emulsion and drilling mud in a cylindrical vessel using a propeller-type mixer. In this case, the calculated amount of drilling mud was poured in portions into a vessel pre-filled with the required volume of emulsion. Before the tests, the prepared “aging” emulsions were additionally kept for 2 hours at the cooking temperature, during which the armor shell was formed on the water globules.

Testing the demulsibility of DMO 25126 and Dissolvan 13853 was carried out by the method of standard static settling - "bottle sample". The emulsion was poured into graduated sedimentation tanks (Lysenko type), 100 ml each. At the temperature of oil preparation, the calculated amount of demulsifier was dosed into the emulsion in the form of a commercial form using a microsyringe with dosages of 100, 200, 300 grams per ton of oil. Then the emulsion was thoroughly mixed for 3 - 5 minutes using shakers, set to thermostat at the temperature of oil preparation (50 ° C). The settling time was 6 hours.

The volume of released water was recorded at certain intervals after reaching the set temperature of the sediment in the sedimentation tanks. To assess the activity of demulsifiers in the presence of drilling fluid, the experiment included two “blank” experiments, the emulsion was processed under the same conditions, in the first case without adding drilling fluid, in the second case without adding a base demulsifier and drilling fluid. The residual water cut values were determined experimentally.

After settling for 6 hours, the water-oil layer of the emulsion was taken to determine the residual content of chloride salts according to GOST 21534-76 from the upper, middle and lower levels in a ratio of 1: 3: 1, as well as to determine the density by the express method.

The amount of separated water from the oil-water emulsion for a certain period of time is calculated by the formula:

$$W_{sep.water} = \frac{V_i}{V_{source\ water}} \cdot 100 \quad (1)$$

Where:

V_i - is the amount of water separated from the emulsion for a certain period of time, *ml*;

$V_{source\ water}$ - the amount of water contained in the original oil-water emulsion, *ml*.

The residual water content in the emulsion is determined from the formula:

$$W_{res.water} = \frac{W_{in.water\ cut} \cdot 0,01 \cdot V_{sample} - V_i}{V_{sample} - V_i} \quad (2)$$

Where:

$W_{res.water}$ - residual water content in the oil phase,%;

$W_{in.water\ cut}$ - initial water cut of the emulsion sample,%;

V_{sample} - is the volume of the sample taken for demulsification, *ml*;

V_i - is the amount of water separated from the emulsion for a certain period of time, *ml.*

2.3 Determination of the influence of the acidity of the medium on the process of demulsification of an oil-water emulsion with drilling mud by the method of static sludge - "bottle sample"

To determine the effect of the acidity of the medium on the process of demulsification of the water-oil emulsion of the SBOGKM in the presence of drilling mud in the emulsion, the solutions of caustic soda and hydrochloric acid with concentrations of 3%, 6%, 12%, 24% were dosed using a dispenser in a ratio of 1:10. Then the emulsion was stirred for 3 minutes, thermostated at the preparation temperature. The settling time was 6 hours.

The volume of released water was recorded at certain intervals after reaching the specified temperature of the sediment in the settling tanks. To assess the effect of caustic soda and hydrochloric acid on the separation of an oil-water emulsion in the presence of drilling mud and a base demulsifier, a "blank" experiment was included in the experiment - the emulsion was processed under the same conditions, without adding a solution of caustic soda and hydrochloric acid. The residual water cut values were determined experimentally.

3 Results and discussion

As a result of the tests carried out on the compatibility of the Flo-Pro NT drilling fluid with formation water sampled from the Srednebotuobinsky oil and gas condensate field, the following data were obtained, presented in table 2.

Table 2. Compatibility of Flo-Pro NT drilling fluid with formation water sampled from the Srednebotuobinsky oil and gas condensate field.

Chemical reagent concentration, g / dm^3	Density of liquid, kg / m^3	The presence of delamination, gel
at 20 ^{0}C		
0	1157	-
10	1183	Yes
30	1210	Yes
50	1252,3	Yes
70	1266,8	No
90	1268,7	No
at 12^{0}C (reservoir temperature)		
0	1220	-
10	1221,7	Yes
30	1246	Yes
50	1269	Yes
70	1272,6	No
90	1275,5	No

As can be seen from the data, at a drilling mud concentration of more than 70 g / dm^3, no visible signs of incompatibility between formation water and drilling mud are observed. This, in turn, is possibly related to the stabilization of the resulting mixture.

The efficiency of demulsifiers DMO 25126 and Dissolvan 13853 is shown in fig. 1.

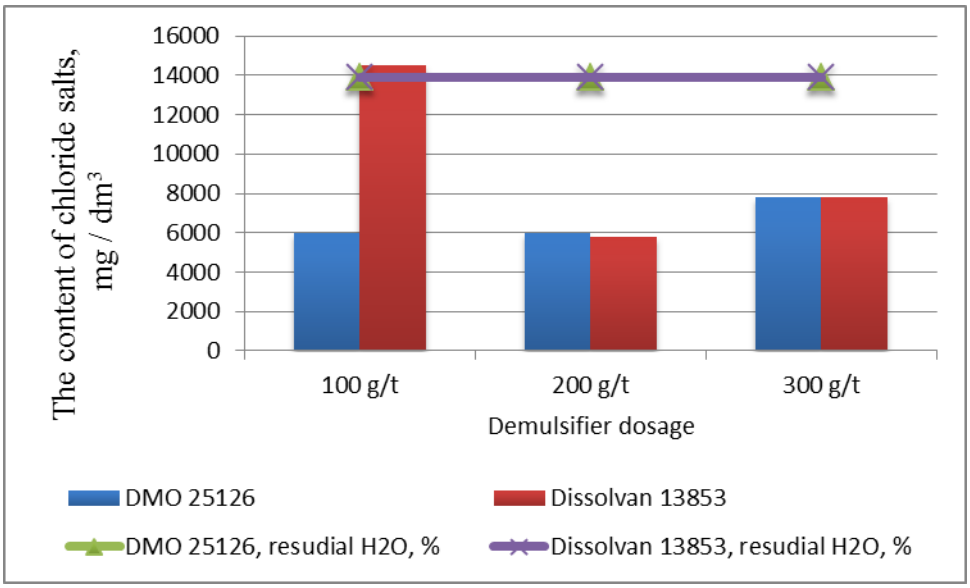

Fig.1. Dependence of demulsification of oil-water emulsions of the Srednebotuobinskoye field on the dosage of demulsifiers DMO 25126 and Dissolvan 13853.

An increase in the dosage of a demulsifier from 100 g/t to 300 g/t does not significantly affect the efficiency of breaking the emulsion. The residual water content remains at 6%.

When using the demulsifier Dissolvan 13853, a significant decrease in the content of chloride salts by 61% was observed with an increase in the dosage of the demulsifier from 100 g/t to 200 g/t.

The demulsifier DMO 25126 already at a dosage of 100 g/t reduced the content of chloride salts by 58%, while a further increase in the dosage of the demulsifier, even with a threefold increase from 100 g/t to 300 g/t, did not lead to a significant decrease in the content of chloride salts.

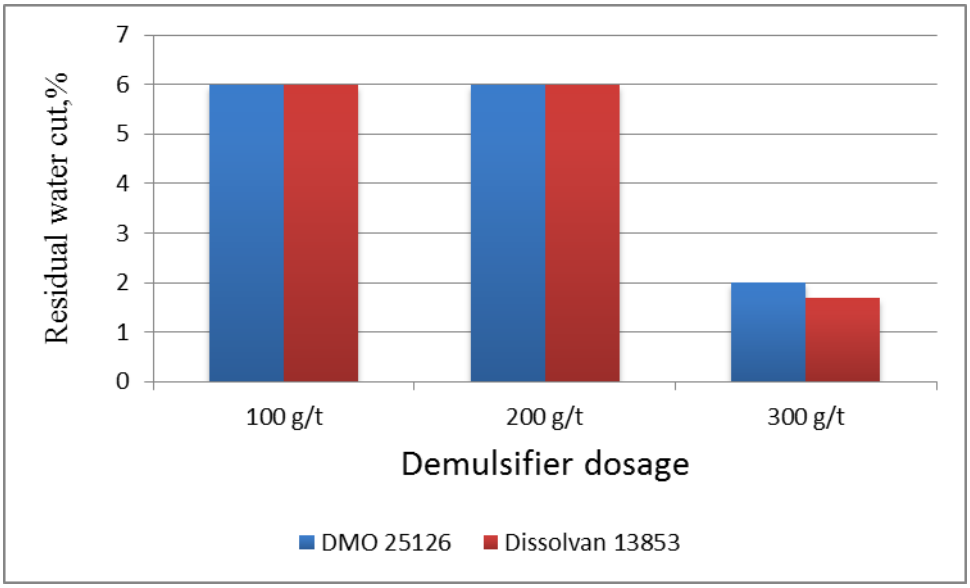

Fig. 2. Dependence of residual water cut at the second stage of preparation of the emulsion of the Srednebotuobinskoye field on the dosage of the demulsifier with the addition of 3% caustic soda and hydrochloric acid.

When determining the effect of the acidity of the medium on the demulsification process at dosages of demulsifiers of 100 and 200 g/t, no changes were observed in the demulsification process. At the same time, with a demulsifier dosage of 300 g/t, the residual water cut decreased by 65% with the addition of 3% caustic soda. A further increase in the concentration of caustic soda up to 8 times did not lead to a significant decrease in the water cut of the emulsion.

A decrease in the acidity of the medium showed a "positive" result of a 72% decrease in residual water cut when using 3% HCl.

4 Conclusions

1. At a dosage of Dissolvan 13853 demulsifier 300 g/t, the addition of caustic soda with a concentration of 3% reduces the water cut in the second stage by 65%, the addition of 3% hydrochloric acid by 72%;
2. The Flo-Pro NT drilling mud for the conditions of the Srednebotuobinskoye oil and gas condensate field is applicable at mud concentrations exceeding 5%, which is confirmed by sedimentation at values of formation water concentration exceeding 95%.
3. The best result in reducing the content of chloride salts is observed when using demulsifier DMO 25126, while the decrease in the content of chloride salts by almost 60% at the first stage of preparation is achieved at a dosage of 100 g/t.
4. The efficiency of using demulsifier DMO 25126 together with Flo-Pro NT drilling fluid is not affected by the acidity of the medium.

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