ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Selection Of A Technological Mode To Reduce Salts And Water In The Product Oil Of Orenburg And Kopansk Oil-Gas Condensate Fields.

Kuryakova TA[1], Mezhueva LV[2], Bykov AV[2]*, Popov VP[2], and Berestova AV[2].

[1]Orenburg branch of the Russian State University of Oil and Gas named after I. M. Gubkin, Orenburg.
[2]Orenburg State University, Orenburg.

ABSTRACT

During transporting in wells, oil gets very intensively mixed with brine water. During well handling, oil closely contacts with the water. Persistent oil emulsions often form in these cases. To improve oil de-emulsification, one needs to choose particular reagents and their dosage, and the optimal temperature regime. Installation of preparation and pumping of liquid hydrocarbons from production oil is processed in automated modular thermochemical devices. The main element of such technologies is breaking water-in-oil emulsions by using chemical reagents – demulsifiers, heating, coalescence of water drops dispersed in oil, and sedimentation of the coalesced drops. Selection of demulsifiers in each case is based on special laboratory and field studies. There was carried out the performance analysis of the 4-th technological line of the Gas Processing Facility-10, which prepares crude oil from Assel deposits of the Orenburg gas condensate field and mix oils from Kopansk OGCF. There were also held laboratory qualifying tests of demulsifiers and industrial tests of experimental batches of demulsifiers “Hercules 2134” and “Hercules 2601”. Testing the effectiveness of the samples was carried out on fresh samples of oil emulsions of Assel oil, Kopansk gas condensate, and mix oils produced by the GPF-10 (C-203 and C-402H). Tests were carried out under static conditions with thermochemical water-oil emulsions breaking down by “the bottle roll test” technique.

Keywords: product oil, brine water, demulsifiers, emulsion, oil-gas condensate, bottle roll test

**Corresponding author*

INTRODUCTION

Water in oil leads to a significant increase in heat consumption to heat up the oil while processing, the emergence of a large amount of water vapor in the apparatus, which leads to a sharp increase of pressure in the system and mechanical damage and rupture in the technological regime. Water-dissolved salts get into oil together with the water.

MATERIALS AND METHODS

Water in crude oils and its products may be in the form of an emulsion or dissolved. There are qualitative and quantitative methods of water content measurement in crude oils and its products.

The qualitative methods are the tests on transparency, crackling sounds, and the test paper.

The quantitative methods include chemical determination of dissolved water (the calcium hydride method), as well as the widespread method of water flashing off in the presence of a solvent.

The essence of the latter method (GOST 2477-2014) lies in flashing the water and the solvent off the oil with further separation into two layers in a graduated receiver. The solvent, which is gasoline, is injected into the test product to eliminate tremor and foaming that accompany boiling oil containing water [6].

A sample of the test product is intermingled within 5 minutes. Approximately 100 g of the test product is weighed out into a dry and clean flask 1 with precision to 0.1 g, followed by adding 100 ml of ligroin and intermingling.

After that the installation gets gathered, water gets into the condenser flask and heating the flask starts from the bottom by a burner through an asbestos net. The heating is adjusted so that 2-4 drops per second trickle down from the condenser into the receiver-trap. Evolved vapors of oil and water are condensed in the condenser flask and are collected in the receiver-trap where water forms the bottom layer due to the difference in the densities.

When the amount of water in the trap ceases to grow and the top layer of the solvent becomes transparent, the distillation is discontinued. Then the volume of the bottom water layer in the trap gets measured. Assel oil of Orenburg gas condensate field (OGCF) was chosen for our tests.

Water content (% by mass) is calculated using the formula:

$$X = [V \times \rho / G] \times 100$$

where X – 2,2 % of the mass content of water in oil, %mass.;
V – 220 sm^3 volume of water in the trap, sm^3;
ρ - 1000 g/ sm^3 density of water at the temperature of measuring, g/ sm^3;
G – 100 g mass of a sample of the oil, g.

The time of distillation was 62 minutes.

When the demulsifier “Hercules 2134” was added, a bigger amount of water was evolved (3.4%mass.), the time of distillation was 20 minutes. Demulsifier consumption: 0.03 g per kg of oil.

RESULTS AND DISCUSSION

The results of tests on demulsifiers in the destruction of model emulsions of Assel oil are shown in table 1. Two best samples of demulsifiers: ARF-6 (“Hercules 2134”) and 98-005 (“Hercules 2601”) were selected based on the results of the qualifying tests at low temperatures, simulating the most severe winter conditions for the preparation of oil at the Gas Processing Facility-10 (GPF-10). They exceeded in effectiveness the demulsifier diproxamin 157-65M, which was in use at that time.

The effectiveness of the recommended samples of demulsifiers "Hercules 2134" and "Hercules-2601" was confirmed by experimental-industrial runs at the GPF-10. The results of the experimental-industrial tests of demulsifiers on GPF-10 are given in tables 2 and 3.

Thus, on the basis of the analysis of our works on the 4-Th technological line of the GPF-10, we chose the best conditions of the process for the preparation of Assel and Kopansk oil and Kopansk gas condensate.

The consolidated return on the results of the tests and the conditions of the process is shown in table 4.

The outcome of the tests was the selection of samples of the demulsifiers that would provide the best results in the destruction of the oil-water emulsions and be cost-effective when applied in oil preparation technology.
For comparative tests, we applied the following demulsifiers: Diproxamin 157-65M, "Hercules2134", and "Hercules 2601".

The results of the laboratory comparative tests of the demulsifiers are shown in table 5.

Based on the results of the comparative tests of demulsifiers, there can be made conclusions that the most effective is "Hercules 2134".

Held in the BCS-1 and the GPF-10, the experimental-industrial tests showed that the application of the new highly effective oil-solvable demulsifiers provides more profound dehydration and desalting of the condensate and crude oil than without a demulsifier. The recommended consumption for demulsifier "Hercules 2601" is 30-50 g/t (table 5). It should be noted, however, that the data of the tests and analysis of the GPF-10 performance showed that, in order to obtain the desired level of the dehydration and desalting of gas condensate and oil, application of only a demulsifier is not enough, even highly effective ones, and it is also necessary to improve the technology of preparation (higher temperatures, longer time of sludge, freshwater flushing), particularly in the preparation of mixtures of oils of the Kopansk deposits, which are characterized with a high content of chloride salts, emulsified water, mechanical impurities, asphaltic-resinous substances, paraffin, and high viscosity.

Dehydration of crude oil and condensate to the residual water content in average to 0.5% leads to a respective reduction of the chloride level to 700-800 mg/l on average (considering that the salinity of brine water averages 150000 mg/l in terms of NaCl and without crystalline salts).

Studies show we could avoid freshwater flushing the crude provided that the salinity of brine water does not exceed 75000-80000 mg/l.

According to the results of the tests, to ensure the required quality of oil preparation (not higher than 400 mg/l) on the 4-th line of the GPF-10, we need to double (theoretically) dilution of brine water with fresh water. In practice: three-fourfold dilution. So, it is needed to expose the crude to freshwater flushing with 3-6%vol. fresh water. (Table 6).

Based on the analysis of the reconstruction of oil production lines of the GPF-10 for a separate oil preparation of Assel deposits in Orenburg Gas Condensate Field and Kopansk Oil-gas Condensate Field for washing salts off, fresh water should be introduced in the amount of 5.5% of the volume of incoming crudes. Water supply is projected as separate streams into the process line of Assel and Kopansk oil.

Rated water consumption into Assel production line is 1.12 m^3/h, operating pressure in the discharge line equals 3.0 MPa.

Rated rinsing water consumption for injecting into Kopansk oil is 0.6 m^3/h, the pressure in the discharge is 2.5 MPa.

ISSN: 0975-8585

Table 1 – Results of tests on demulsifiers in destruction of model emulsions of Assel oil

No.	Demulsifier	Consumption (g/t)	Thermosludge at 5(2)^{0}C (1st stage)						Thermosludge at 20^{0}C (2nd stage)			Centrifugation of elutriated water		
			Temperature (^{0}C)	Volume of the water evolved from emulsion (% vol.), in:					Volume of the water evolved from emulsion (% vol.), in:					
				10 min	20 min	30 min	45 min	60 min	10 min	20 min	30 min	Emulsion	Water	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Assel oil + 20% brine water														
1.	Control test (without demulsifier)	0	5	0	0	tr.	tr.	-	tr.	-	tr.	15	5	20
2.	Diproxiamin 157-65M	20	5	tr.	1	3	5	-	8	-	10	4,5	5,5	10
3.	CB 682	20	5	3	5	5	9	-	10	-	12	3,5	5,5	9
4.	CB 682A	20	5	2	3	5	7	-	9	-	11	2,8	2,2	5
5.	45-39-2	20	5	tr.	2	4	5	-	9	-	10			
6.	45-39-3	20	5	tr.	tr.	2	4	-	8	-	11			
7.	ARF 8	20	5	5	7	9	10	-	13	-	14	3	2	5
8.	ARF 9	20	5	4	8	10	10	-	14	-	14	1,8	1	2,8
9.	ARF 11	20	5	tr.	2	5	8	-	10	-	11			
10.	ARF 4	20	5	1	3	6	9	-	10	-	12			
11.	AR 3	20	5	tr.	5	9	9	-	12	-	14	0,5	5	5,5
12.	CP 2121	20	5	tr.	tr.	4	5	-	9	-	11			
13.	CP 2140	20	5	1	3	3	5	-	8	-	10			
14.	CP 2159	20	5	tr.	tr.	3	4	-	7	-	11			
15.	CP 2127	20	5	2	4	6	8	-	10	-	12			
16.	CP 2135	20	5	tr.	1	3	7	-	9	-	13			
17.	98-001	20	5	tr.	3	3	6	-	9	-	12			
18.	ARF 6	20	5	58	8	10	10	-	13	-	15	0,2	4,8	5
2. Assel oil + 25% brine water														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
19.	Control test (without demulsifier)	0	5	tr.	-	tr.	-	1	-	25	-	22	3	25
20.	Diproxamin 157-65M	20	5	5	-	6	-	8	-	25	-			
21.	AR	20	5	0	-	0	-	0	-	25	-			
22.	AR	20	5	2	-	4	-	5	-	25	-			
23.	AR	20	5	6	-	10	-	15	-	25	-			
24.	AR	20	5	8	-	10	-	16	-	25	-			
25.	98-002	20	5	1	-	1	-	1	-	25	-			
26	98-003	20	5	1	-	1	-	1	-	25	-			
27.	98-003	20	5	1	-	1	-	1	-	25	-			
28.	ARF	20	5	8	-	13	-	18	-	25	-			
3. Assel oil + 25% brine water														
29.	Control test (without demulsifier)	0	2	0	0	0	-	0	3	17	-			
30	Diproxamin157-65M	20	2	3	5	7	-	10	22	25	-	0,6	0,3	0,9
31	ARF 6	20	2	10	12	15	-	17	25	25	-	0,3	0,2	0,5

ISSN: 0975-8585

32.	AR 6	20	2	5	8	11	-	13	23	25	-	0,6	1	1,6
33.	AR 8	20	2	8	11	13	-	15	22	25	-	0,6	0,8	1,4
34.	AR 3	20	2	3	7	7	-	12	22	25	-	0,7	0,7	1,4
35.	ARF 9	20	2	1	2	3	-	8	20	25	-	0,8	0,8	1,6
36	ARF 8	20	2	tr.	3	7	-	10	22	25	-			
37.	CB 682	20	2	9	11	15	-	15	23	25	-	0,6	0,7	1,3
38.	98-005	20	2	10	12	15	-	16	22	25	-	0,2	0,4	0,6

4. Mix of gas condensates and oil from BCS-1 + 25% brine water														
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
39.	Control test (without demilsifier)	0	2	2	2	4	-	6	20	25	25	-		
40.	Diproxamin 157-65M	20	2	10	12	1	-	20	20	25	25	-		
41.	ARF6	20	2	20	25	25	-	25	20	25	25	-		

Table 2 – Comparative averaged results of condensate preparation during the industrial tests of an experimental batch of the demulsifier "Hercules 2601" at the GPF-10

Type of demulsifier	Consumption	Content of free water in the gas condensate after the 1st stage (C-203) (% mass.)	Content of emulsified water in the gas condensate after the 1st stage (C-203) (% mass.)	Content of chlorides in the gas condensate after the 1st stage (C-203) (mg/l)	Content of free water in the gas condensate after the 2nd stage (C-203) (% mass.)	Content of emulsified water in the gas condensate after the 2nd stage (C-203) (% mass.)	Content of chlorides in the gas condensate after the 2nd stage (C-203) (mg/l)
Without demulsifier	0				0,7	0,27	1263
Hercules 2601	50,5	abs.	0,21	628	0,09	0,07	378

Table 3 – Comparative averaged results of industrial tests for the experimental batches of demulsifier "Hercules 2601"

Demulsifier	Consumption (g/t)	Content of free water in gas condensate (% mass.)	Content of emulsified water in gas condensate (% mass.)	Content of chlorides in gas condensate (mg/l)
Without demulsifier	0	0,74	0,36	1263
Hercules 2601	50,5	0,4	0,06	231,4

Table 4 – Consolidated return on selecting conditions of oil preparation in the GPF-10

Index	Unit	I half-line	II half-line
Crude:		Assel oil	Kopansk oil mixed with Kopansk gas condensate and "Corbon Oil"
Productivity	m^3/day	440	194
Pressure	MPa	2,0	2,0
Temperature	^0C		
I stage		10 (C-402H)	10 (C-403)

II stage		30 (B-408B)	55 (B-408A)
Time of sludge	min		
I stage		7	112
II stage		18	107
Demulsifier		Hercules 2134	Hercules 2134
Consumption of demulsifier	mg/t of oil	30-50	30-50

Table 5 – Results of the laboratory comparative tests of the demulsifiers

Demilsifier	Volume of evolved water (%vol) in (min):			Water residual (%vol.)
	10	30	45	
Without demulsifier	0	tr.	tr.	5
Diproxamin 157-65M	tr.	1	1,5	3,5
"Hercules 2601"	1,5	3	4,2	0,8
"Hercules2134"	2	3,5	4,8	0,2

Table 6 – Demulsifier and rinsing water consumption for technological needs of oil preparation processes in the GPF-10

Reagent	Point of introduction	Consumption	
		min	max
Demulsifier of the "Hercules" type	Into the crude before rinsing water C-402 C-403	 30 g/t 30 g/t	 50 g/t 50 g/t
Rinsing water, % vol. per crude	Before mixing complex (MC) СК-1, СК-2 (MC-1, MC-2)	3	6

CONCLUSIONS

Thus, the mode of the separate desalting and dehydration of Assel and Kopansk oils using demulsifier "Hercules 2134", described above, guarantees the quality of product oil in accordance with specifications.

REFERENCES

[1] Akhmetov SA. Deep processing technology of oil and gas. Gilem, Ufa, 2002. 672 p.

[2] Technological Rules 1-22-2010: Technological rules for operation BCS-1 from the Gas Production Department of LLL "Gazprom Dobycha Orenburg"

[3] Nikitin VI, Donskov KV, Molchanova ZV. Natural Gas Industry 2001; 6.

[4] Rudnenko CS, Khutoryanskiy F.M., Kapustin VM. Oil Refining 2010; 11: 3-9.

[5] Kirillova LB, Pivovarova NA, Vlasova GV. Oil Refining 2011; 1: 13-16.

[6] Rumyantsev AI, Ivanov VV. Oil Processing and Petrochemistry 2009; 10: 42-44.