

ECONOMIC EFFECT FROM THE IMPLEMENTATION OF NANOECOLOGICAL TECHNOLOGY IN THE CONDITIONS OF PRIMARY PREPARATION OF OIL

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Abstract: *It is noted that nanoecological technology in the practice of primary preparation of oil (PPO) is studied in more detail for the first time. One of the priority issues in this area is the economic assessment of the state of implementation of nanoecological technology. This article is devoted to these issues. The article presents the results of calculating the actual and expected economic effects from the implementation of nanoecological technology using demulsifiers with a polynostructure of the “IKHLAS” type, in the conditions of PPO at six fields of the Republic of Kazakhstan, taking into account the data of 2024. During the literature search on the issues of nanoecological technology in the conditions of primary preparation of oil (PPO), no relevant information was found. The only exceptions were the works published by us [1-9]. Therefore, the development of this area is of particular ecological and technological relevance in general for global oil production. One of the priority issues in this area is the economic assessment of the state of implementation of nanoecological technology in the conditions of PPO. This article is devoted to these issues. The purpose of the work: Calculation of the economic effect from the implementation of nanoecological technology in the conditions of PPO. The calculation of the economic effect includes the following sections: Introduction; 1. Calculation of the actual economic effect during the pilot tests and the annual expected economic effect for the “IKHLAS-1” nanodemulsifier*

at the “Zhetybai” field of MMG JSC; 2. Calculation of the actual annual economic effect from the implementation of “IKHLAS-1” at the “Tenge Oil & Gas” field; 3. Calculation of the actual annual economic effect from the introduction of the nanodemulsifier “IKHLAS-1” at the “Phystech II” JSC field; 4. Calculation of the actual annual economic effect from the introduction of the nanodemulsifier “IKHLAS-1” at the Akkulka field of TetisAralGaz LLC; 5. Calculation of the actual annual economic effect for nanodemulsifiers “IKHLAS-1” and “IKHLAS-2” at the fields and OPPSh (oil preparation and pumping shop) of OGPD (oil and gas production department) “Zhaikmunaigas” of JSC “Embamunaigas”; 6. Calculation of the actual annual economic effect for the nanodemulsifier “IKHLAS-1” at the “Karsak” Central Processing Plant and the “Botakhan” field of the “Dossormunaigas” Oil and Gas Production Department (OGPD) of “Embamunaigas” JSC. As a result of the systematic calculations, it was found that the actual and expected economic effects from the implementation of nanoecological technology using “IKHLAS” nanodemulsifiers, in the conditions of PPO at the studied oil-fields of the Republic of Kazakhstan amount to \$ 604,402 and \$ 2,272,610, respectively. At the same time, the level of contamination of waste formation water with oil was 2.5-42 times lower in comparison with basic technologies and did not exceed the levels of the current standard (50 mg/dm³).

Key words: nanoecological technology, economic efficiency from the implementation of demulsifiers “IKHLAS” with polynostructure, reduction of pollution levels of waste formation water with oil

Introduction. During the literature search on the issues of nanoecological technology in the conditions of primary preparation of oil (PPO), no relevant information was found. The only exceptions were the works published by us [1-9]. Therefore, the development of this area is of particular ecological and technological relevance in general for global oil production. One of the priority issues in this area is the economic assessment of the state of implementation of nanoecological technology in the conditions of PPO. This article is devoted to these issues. The purpose of the

work: Calculation of the economic effect from the implementation of nanoecological technology in the conditions of PPO. The economic calculation of the implementation of nanoecological technology in the conditions of PPO is presented for six oil fields of the Republic of Kazakhstan (“Zhetybai” field of MMG JSC; “Tenge Oil & Gas”; “Phystech II” JSC; Akkulka field of TetisAralGaz LLC; OPPSh (oil preparation and pumping shop) of OGPD (oil and gas production department) “Zhaikmunaigas” of JSC “Embamunaigas”; Botakhan field of the Dossormunaigas Oil and Gas Production Department of Embamunaigas JSC). Based on 2019 data, the preliminary calculation is presented in [10], and the present calculation is based on 2024 data. The work was carried out, on the basis of an agreement on scientific and technical cooperation between Azerbaijan State Oil and Industry University and “International Oil Services Kazakhstan” LLP.

1. Calculation of the actual economic effect during the pilot tests and the annual expected economic effect for the “IKHLAS-1” nanodemulsifier at the “Zhetybai” field of MMG JSC

Initial data:

During the period from 03.11.14 to 03.12.14, pilot tests of the nanodemulsifier “IKHLAS-1” were carried out at the “Zhetybay” field of JSC “MMG”. The results were quite successful;

Base demulsifier: “Randem-2219”;

The cost of one ton of “Randem-2219” is 1,684,900 tenge;

The cost of one ton of “IKHLAS-1” is 1,394,400 tenge;

The volume of annual oil production: 2,157,300 tons;

The average monthly oil production: $2,157,300:12 = 179,775$ tons.

The average specific consumption of the base demulsifier “Randem-2219” is 204 g/t;

Average specific consumption of nanodemulsifier “IKHLAS-1” is 178 g/t;

Recommended average specific consumption of nanodemulsifier “IKHLAS-1” is 160 g/t;

Daily volume of hard to destroy water-oil emulsions (HDWOE), formed at the basic technology is $\sim 100 \text{ m}^3$, and the annual volume is $36,500 \text{ m}^3$;

Costs for processing 1 m^3 HDWOE on a tricanter for the basic technology are 20,916 tenge;

Average specific consumption of nanodemulsifier “IKHLAS-1” for processing HDWOE together with crude oil is 178 g/t, i.e. no additional dosages is required;

Calculation of the actual economic effect with the “IKHLAS-1” pilot tests:

Annual consumption of “Randem-2219”: $(204 \times 2,157,300)/1,000,000 = 440 \text{ t}$;

Average monthly consumption of “Randem-2219”: 36.7 t;

Average monthly costs for processing 3000 m^3 of HDWOE on a tricanter: $3000 \times 20,916 = 62,748,000$ tenge

Cost of 36.7 tons of “Randem-2219”: $1,684,900 \times 36.7 = 61,835,830$ tenge

Total monthly costs of “Randem-2219”: $61,835,830 + 62,748,000 = 124,583,830$ tenge

Actual costs of “IKHLAS-1” for 1 month (03.11.14-03.12.14): $1,394,400 \times 32 = 44,620,800$ tenge.

Actual economic effect of the pilot testing of “IKHLAS-1”:

$124,583,830 - 44,620,800 = 79,963,030$ tenge (\$177,514, dollar to tenge exchange rate on 06.08.24: $1\$ = 450.46$ tenge).

Results:

1. The actual economic effect of the pilot testing of “IKHLAS-1” at “Zhetybai” of MMG JSC is 79,963,030 tenge (\$177,514).

2. The level of reduction of the concentration of oil and oil products in the composition of formation water from $600\text{--}1400 \text{ mg/dm}^3$ to $20\text{--}28 \text{ mg/dm}^3$ (42 times reduction on average) meets the requirements of the formation pressure maintenance (oil in the composition of formation water is not more than 50 mg/dm^3).

Calculation of the actual economic effect with the IKHLAS-1 pilot testing:

Annual consumption of “Randem-2219”: $(204 \times 2,157,300)/1,000,000 = 440 \text{ t}$;

Average monthly consumption of “Randem-2219”: 36.7 t;

Average monthly costs for processing 3000 m³ of HDWOE on a trican: 3000 x 20,916 = 62,748,000 tenge;

Cost of 36.7 tons of “Randem-2219”: 1,684,900 x 36.7 = 61,835,830 tenge

Total monthly costs of “Randem-2219”: 61,835,830 + 62,748,000 = 124,583,830 tenge

Actual costs of “IKHLAS-1” for 1 month (03.11.14-03.12.14): 1,394,400 x 32 = 44,620,800 tenge.

Actual economic effect of the pilot testing of “IKHLAS-1”:

124,583,830 - 44,620,800 = 79,963,030 tenge (\$177,514, dollar to tenge exchange rate on 06/08/24: 1\$=450.46 tenge).

Results:

1. The actual economic effect of the pilot testing of “IKHLAS-1” at “Zhetybai” of MMG JSC is 79,963,030 tenge (\$177,514).

2. The level of reduction of the concentration of oil and oil products in the composition of formation water from 600-1400 mg/dm³ to 20-28 mg/dm³ (42 times reduction on average) meets the requirements of the formation pressure maintenance (oil in the composition of formation water is not more than 50 mg/dm³).

2. Calculation of the actual annual economic effect from the implementation of “IKHLAS-1” at the “Tenge Oil & Gas” field

Initial data:

In the period from 10.05.17 to 05.06.17, pilot tests of the “IKHLAS-1” nanodemulsifier were carried out at the “Tenge Oil & Gas” field. Since the beginning of 2018, the “IKHLAS-1” nanodemulsifier is successfully implemented at the “Tenge Oil & Gas” field.

Basic demulsifier: “Dissolvan V 5748” (Germany);

Cost of one ton of “Dissolvan V 5748”: 1,859,200 tenge;

Cost of one ton of “IKHLAS-1”: 1,394,400 tenge;

Volume of annual oil production: 116,340 tons;

Average specific consumption of the basic demulsifier “Dissolvan V 5748” is 186 g/t;

Average specific consumption of the nanodemulsifier “IKHLAS-1” is 170 g/t;

Concentration of oil and oil products in the composition of formation waters in the case of the basic demulsifier “Dissolvan V 5748” is 370-1290 mg/dm³;

Concentration of oil and oil products in the composition of formation waters in the case of the “IKHLAS-1” does not exceed 46 mg/dm³.

Calculation of the actual annual economic effect from the implementation of “IKHLAS-1”:

Annual consumption of “Dissolvan V 5748” $(186 \times 116,340)/1,000,000 = 21.6$ tons;

Cost of 21.6 tons of “Dissolvan V 5748” $1,859,200 \times 21.6 = 40,158,720$ tenge

Annual consumption of “IKHLAS-1” $(170 \times 116,340)/1,000,000 = 19.8$ tons

Cost of 19.8 tons of “IKHLAS-1”: $1,394,400 \times 19.8 = 27,609,120$ tenge

Actual annual economic effect from the implementation of “IKHLAS-1”:

$40,158,720 - 27,609,120 = 12,549,600$ tenge (\$27,859)

Results:

1. The actual annual economic effect from the implementation of “IKHLAS-1” at the “Tenge Oil & Gas” field is Gas” is 12,549,600 tenge (\$27,859);

2. The level of reduction of the concentration of oil and oil products in the composition of formation waters from 370-1290 mg/dm³ to 46 mg/dm³ (18 times reduction on average) meets the requirements of the reservoir pressure maintenance (oil in the composition of formation waters no more than 50 mg/dm³).

3. Calculation of the actual annual economic effect from the introduction of the nanodemulsifier "IKHLAS-1" at the "Phystech II" JSC field

Initial data:

In the period from 12.04.17 to 17.04.17, pilot tests of the nanodemulsifier "IKHLAS-1" were carried out at the "Phystech II" JSC field. Since the beginning of 2018, the nanodemulsifier "IKHLAS-1" is successfully implemented at the "Phystech II" JSC field;

Base demulsifier: "SNPKh-4315D" (Russia);

The cost of one ton of "SNPKh-4315D" is 1,801,100 tenge;

The cost of one ton of "IKHLAS-1"; 1,394,400 tenge;

The volume of annual oil production: 156,950 tons;

Average specific consumption of the basic demulsifier "SNPKh-4315D" 221 g/t;

Average specific consumption of the nanodemulsifier "IKHLAS-1" 100 g/t;

Concentration of oil and oil products in the composition of formation waters of "SNPKh-4315D" is 200-470 mg/dm³;

Concentration of oil and oil products in the composition of formation waters "IKHLAS-1" does not exceed 47.8 mg/dm³.

Calculation of the actual annual economic effect from the implementation of "IKHLAS-1":

Annual consumption of "SNPKh-4315D" $(221 \times 156,950)/1,000,000 = 34.7$ tons;

Cost of 34.7 tons of "SNPKh-4315D" $1,801,100 \times 34.7 = 62,498,170$ tenge;

Annual consumption of "IKHLAS-1" $(100 \times 156,950)/1,000,000 = 15.7$ tons;

Cost of 15.7 tons of "IKHLAS-1": $1,394,400 \times 15.7 = 21,892,080$ tenge;

Actual annual economic effect from the implementation of "IKHLAS-1": $62,498,170 - 21,892,080 = 40,606,090$ tenge (\$90,143).

Results:

1. Actual annual economic effect from the implementation of "IKHLAS-1" at the "Phystech" field II" JSC is 40,606,090 tenge (\$90,143)

2. The level of reduction of the concentration of oil and oil products in the composition of formation waters from 200-470 mg/dm³ to 47.8 mg/dm³ (7 times reduction on average) meets the requirements of the reservoir pressure maintenance (oil in the composition of formation waters no more than 50 mg/dm³).

4. Calculation of the actual annual economic effect from the introduction of the nanodemulsifier "IKHLAS-1" at the Akkulka field of TetisAralGaz LLC

Initial data:

In the period from 14.08.17 to 26.08.17, pilot tests of the nanodemulsifier "IKHLAS-1" is successfully implemented at the Akkulka field of TethysAralGaz

LLC. Since the beginning of 2018, the nanodemulsifier “IKHLAS-1” is successfully introduced at the Akkulka field of TethysAralGaz LLC.

Base demulsifier: “DMO-86520” (“Baker Hughes”, USA);

The cost of one ton of “DMO-86520” is 2,440,200 tenge;

The cost of one ton of “IKHLAS-1”; 1,394,400 tenge;

The volume of annual oil production: 254,405 tons;

The average specific consumption of the base demulsifier “DMO-86520” is 69.6 g / t;

Average specific consumption of nanodemulsifier “IKHLAS-1” is 40.4 g/t;

Concentration of oil and oil products in the composition of formation waters “DMO-86520” is 62-137 mg/dm³;

Concentration of oil and oil products in the composition of formation waters “IKHLAS-1” does not exceed 28 mg/dm³.

Calculation of the actual annual economic effect from the implementation of “IKHLAS-1”:

Annual consumption of “DMO-86520” $(69.6 \times 254\,405) / 1\,000\,000 = 17.7$ tons;

Cost of 17.7 tons of “DMO-86520” $2,440,200 \times 17.7 = 43,191,540$ tenge

Annual consumption of “IKHLAS-1” $(40.4 \times 254,405) / 1,000,000 = 10.2$ tons

Cost of 10.2 tons of “IKHLAS-1”: $1,394,400 \times 10.2 = 14,222,880$ tenge

Actual annual economic effect from the implementation of “IKHLAS-1”:

$43,191,540 - 14,222,880 = 28,968,660$ tenge (\$64,309)

Results:

1. Actual annual economic effect from the implementation of “IKHLAS-1” on the deposit "Akkulka" of TOO "TetisAralGaz" is 28,968,660 tenge (\$64,309).

2. The level of reduction of concentration of oil and oil products in the composition of formation waters from 62-137 mg/dm³ to 28 mg/dm³ (3 times reduction on average) meets the requirements of the reservoir pressure maintenance (oil in the composition of formation waters no more than 50 mg/dm³).

5. Calculation of the actual annual economic effect for nanodemulsifiers “IKHLAS-1” and “IKHLAS-2” at the fields and OPPSh (oil preparation and pumping shop) of OGPD (oil and gas production department) “Zhaikmunaigas” of JSC “Embamunaigas”

Initial data:

In the period from 06.01.18 to 25.01.18, pilot tests of nanodemulsifiers “IKHLAS-1” and “IKHLAS-2” were carried out at the fields and OPPSh of OGPD “Zhaikmunaigas” of JSC “Embamunaigas”. Since the beginning from 01.07.19, the “IKHLAS-1” and “IKHLAS-2” nanodemulsifiers are successfully implemented at the OPPSh of OGPD “Zhaikmunaigas” of JSC “Embamunaigas”;

Basic demulsifiers: “Dissolvan V 4795” and “Dissolvan V 4397” (Germany);

The cost of one ton of “Dissolvan V 4795” and “Dissolvan V 4397” is 1,859,200 tenge;

The cost of one ton of “IKHLAS-1” and “IKHLAS-2”: 1,394,400 tenge;

The volume of annual oil production: 931,115 tons;

The average daily consumption of basic demulsifiers is $89.94 \times 2 = 179.88$ kg.

The average daily consumption of nanodemulsifiers “IKHLAS-1” and “IKHLAS-2”: 89.94 kg

The concentration of oil and oil products in the composition of formation waters “Dissolvan V 4795” and “Dissolvan V 4397” is 50-400 mg/dm³;

The concentration of oil and oil products in the formation waters of “IKHLAS-1” does not exceed 15-50 mg/dm³.

Calculation of the actual annual economic effect for “IKHLAS-1” and “IKHLAS-2”:

Total annual consumption of base demulsifiers: $179.88 \times 365 = 65,656$ kg = 65.656 tons;

Total annual consumption of demulsifiers “IKHLAS-1” and “IKHLAS-2”: $89.94 \times 365 = 32,828$ kg = 32.828 tons;

Cost of 65.656 tons of base demulsifiers “Dissolvan V 4795” and “Dissolvan V 4397”: $65.656 \times 1,859,200 = 122,067,635$ tenge;

The cost of 32,828 tons of nanodemulsifiers “IKHLAS-1” and “IKHLAS-2”:
 $32,828 \times 1,394,400 = 45,775,363$ tenge;

Annual actual economic effect: $122,067,635 - 45,775,363 = 76,292,272$ tenge
 (\$169,365).

Results:

1. The annual actual economic effect for nanodemulsifiers “IKHLAS-1” and “IKHLAS-2” at the fields and OPPSh of OGDU “Zhaikmunaigas” of JSC “Embamunaigas” is 76,292,272 tenge (\$169,365).

2. The level of reduction of the concentration of oil and oil products in the composition of formation waters from 50-400 mg/dm³ mg/l to 15-50 mg/dm³ (6.9 times reduction on average) meets the requirements of the reservoir pressure maintenance (oil in the composition of formation waters no more than 50 mg/dm³).

6. Calculation of the actual annual economic effect for the nanodemulsifier “IKHLAS-1” at the “Karsak” Central Processing Plant and the “Botakhan” field of the “Dossormunaigas” Oil and Gas Production Department (OGPD) of “Embamunaigas” JSC

Initial data:

In the period from 02.02.2019 to 12.02.2019, pilot tests of IKHLAS-1 nanodemulsifiers were conducted at the “Karsak” OPPSh and the “Botakhan” field of the “Dossormunaigas” OGPD of “Embamunaigas” JSC. Since the beginning from 01.07.19, the “IKHLAS-1”, nanodemulsifier is successfully implemented at the “Karsak” OPPSh and the “Botakhan” field of the Dossormunaigas OGPD of “Embamunaigas” JSC;

Base demulsifier: “Dissolvan V 4795” (Germany);

The cost of one ton of “Dissolvan V 4795”: 1,859,200 tenge;

The cost of one ton of “IKHLAS-1”: 1,394,400 tenge;

The volume of annual oil production: 151,840 tons;

Average daily consumption of base demulsifier $78.1 + 16.9 = 95$ kg.

Average daily consumption of nano demulsifier “IKHLAS-1”: $46.1 + 14 = 60.1$

kg

Concentration of oil and oil products in formation water “Dissolvan V 4795” is 50-400 mg/dm³;

Concentration of oil and oil products in formation water “IKHLAS-1” does not exceed 29 mg/dm³;

Calculation of actual annual economic effect for “IKHLAS-1”: Total annual consumption of base demulsifier: $95 \times 365 = 34,675 \text{ kg} = 34.675 \text{ t}$;

Total annual consumption of demulsifier “IKHLAS-1”: $60.1 \times 365 = 21,936 \text{ kg} = 21.936 \text{ tons}$;

Cost of 34,675 tons of basic demulsifier “Dissolvan V 4795”: $34,675 \times 1,859,200 = 64,467,760 \text{ tenge}$;

Cost of 21.936 tons of nanodemulsifiers “IKHLAS-1”: $21,936 \times 1,394,400 = 30,587,558 \text{ tenge}$; Expected annual economic effect: $64,467,760 - 30,587,558 = 33,880,202 \text{ tenge} (\$75,212)$.

Results

1. The annual actual economic effect for the “IKHLAS-1” nanodemulsifier at the “Karsak” OPPSh and the “Botakhan” field of the “Dossormunaigas” OPPSh of “Embamunaigas” JSC is 33,880,202 tenge (\$75,212).

2. The level of reduction of the concentration of oil and oil products in the composition of formation waters from 73 mg/dm³ to 29 mg/dm³ (2.5 times reduction on average) meets the requirements of the reservoir pressure maintenance (oil in the composition of formation waters no more than 50 mg/dm³).

7. Conclusion

Thus, the sum of the annual actual and expected economic effects from the implementation of nanoecological technology using demulsifiers with polynanostructure type "IKHLAS", in the conditions of primary preparation of oil at some of the above-mentioned oil fields of the Republic of Kazakhstan is \$604,402 and \$2,272,610, respectively (there is an official approved document). At the same time, the level of contamination of waste formation water with oil was 2.5-42 times lower in comparison with basic technologies and did not exceed the standard levels (50 mg/dm³).

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