

ISSN 2518-1491 (Online),  
ISSN 2224-5286 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ  
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ

Д.В.СОКОЛЬСКИЙ АТЫНДАҒЫ «ЖАНАРМАЙ,  
КАТАЛИЗ ЖӘНЕ ЭЛЕКТРОХИМИЯ ИНСТИТУТЫ» АҚ

# Х А Б А Р Л А Р Ы

## ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК  
РЕСПУБЛИКИ КАЗАХСТАН

АО «ИНСТИТУТ ТОПЛИВА, КАТАЛИЗА И  
ЭЛЕКТРОХИМИИ ИМ. Д.В. СОКОЛЬСКОГО»

## NEWS

OF THE ACADEMY OF SCIENCES  
OF THE REPUBLIC OF KAZAKHSTAN

JSC «D.V. SOKOLSKY INSTITUTE OF FUEL,  
CATALYSIS AND ELECTROCHEMISTRY»

**ХИМИЯ ЖӘНЕ ТЕХНОЛОГИЯ СЕРИЯСЫ**

**СЕРИЯ ХИМИИ И ТЕХНОЛОГИИ**

**SERIES CHEMISTRY AND TECHNOLOGY**

**5 (431)**

**ҚЫРКҮЙЕК – ҚАЗАН 2018 ж.  
СЕНТЯБРЬ – ОКТЯБРЬ 2018 г.  
SEPTEMBER – OCTOBER 2018**

1947 ЖЫЛДЫҢ ҚАҢТАР АЙЫНАН ШЫҒА БАСТАҒАН  
ИЗДАЕТСЯ С ЯНВАРЯ 1947 ГОДА  
PUBLISHED SINCE JANUARY 1947

ЖЫЛЫНА 6 РЕТ ШЫҒАДЫ  
ВЫХОДИТ 6 РАЗ В ГОД  
PUBLISHED 6 TIMES A YEAR

NAS RK is pleased to announce that News of NAS RK. Series of chemistry and technologies scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of chemistry and technologies in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of chemical sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Химия және технология сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Химия және технология сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді химиялық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия химии и технологий» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по химическим наукам для нашего сообщества.

Б а с р е д а к т о р ы  
х.ғ.д., проф., ҚР ҰҒА академигі **М.Ж. Жұрынов**

Р е д а к ц и я а л қ а с ы:

**Ағабеков В.Е.** проф., академик (Белорус)  
**Волков С.В.** проф., академик (Украина)  
**Воротынцев М.А.** проф., академик (Ресей)  
**Газалиев А.М.** проф., академик (Қазақстан)  
**Ергожин Е.Е.** проф., академик (Қазақстан)  
**Жармағамбетова А.К.** проф. (Қазақстан), бас ред. орынбасары  
**Жоробекова Ш.Ж.** проф., академик (Қырғыстан)  
**Иткулова Ш.С.** проф. (Қазақстан)  
**Манташян А.А.** проф., академик (Армения)  
**Пралиев К.Д.** проф., академик (Қазақстан)  
**Баешов А.Б.** проф., академик (Қазақстан)  
**Бүркітбаев М.М.** проф., академик (Қазақстан)  
**Джусипбеков У.Ж.** проф. корр.-мүшесі (Қазақстан)  
**Молдахметов М.З.** проф., академик (Қазақстан)  
**Мансуров З.А.** проф. (Қазақстан)  
**Наурызбаев М.К.** проф. (Қазақстан)  
**Рудик В.** проф., академик (Молдова)  
**Рахимов К.Д.** проф. академик (Қазақстан)  
**Стрельцов Е.** проф. (Белорус)  
**Тәшімов Л.Т.** проф., академик (Қазақстан)  
**Тодераш И.** проф., академик (Молдова)  
**Халиков Д.Х.** проф., академик (Тәжікстан)  
**Фарзалиев В.** проф., академик (Әзірбайжан)

«ҚР ҰҒА Хабарлары. Химия және технология сериясы».

ISSN 2518-1491 (Online),

ISSN 2224-5286 (Print)

Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» Республикалық қоғамдық бірлестігі (Алматы қ.)

Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 30.04.2010 ж. берілген №1089-Ж мерзімдік басылым тіркеуіне қойылу туралы куәлік

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,  
www.nauka-nanrk.kz / chemistry-technology.kz

© Қазақстан Республикасының Ұлттық ғылым академиясы, 2018

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

Главный редактор  
д.х.н., проф., академик НАН РК **М. Ж. Журинов**

Редакционная коллегия:

**Агабеков В.Е.** проф., академик (Беларусь)  
**Волков С.В.** проф., академик (Украина)  
**Воротынцев М.А.** проф., академик (Россия)  
**Газалиев А.М.** проф., академик (Казахстан)  
**Ергожин Е.Е.** проф., академик (Казахстан)  
**Жармагамбетова А.К.** проф. (Казахстан), зам. гл. ред.  
**Жоробекова Ш.Ж.** проф., академик (Кыргызстан)  
**Иткулова Ш.С.** проф. (Казахстан)  
**Манташян А.А.** проф., академик (Армения)  
**Пралиев К.Д.** проф., академик (Казахстан)  
**Баешов А.Б.** проф., академик (Казахстан)  
**Буркитбаев М.М.** проф., академик (Казахстан)  
**Джусипбеков У.Ж.** проф. чл.-корр. (Казахстан)  
**Мулдахметов М.З.** проф., академик (Казахстан)  
**Мансуров З.А.** проф. (Казахстан)  
**Наурызбаев М.К.** проф. (Казахстан)  
**Рудик В.** проф., академик (Молдова)  
**Рахимов К.Д.** проф. академик (Казахстан)  
**Стрельцов Е.** проф. (Беларусь)  
**Ташимов Л.Т.** проф., академик (Казахстан)  
**Тодераш И.** проф., академик (Молдова)  
**Халиков Д.Х.** проф., академик (Таджикистан)  
**Фарзалиев В.** проф., академик (Азербайджан)

«Известия НАН РК. Серия химии и технологии».

ISSN 2518-1491 (Online),

ISSN 2224-5286 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы)

Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан №10893-Ж, выданное 30.04.2010 г.

Периодичность: 6 раз в год

Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел. 272-13-19, 272-13-18,  
<http://nauka-nanrk.kz / chemistry-technology.kz>

---

© Национальная академия наук Республики Казахстан, 2018

Адрес редакции: 050100, г. Алматы, ул. Кунаева, 142,  
Институт органического катализа и электрохимии им. Д. В. Сокольского,  
каб. 310, тел. 291-62-80, факс 291-57-22, e-mail: [orgcat@nursat.kz](mailto:orgcat@nursat.kz)

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75

## Editor in chief

doctor of chemistry, professor, academician of NAS RK **M.Zh. Zhurinov**

## Editorial board:

**Agabekov V.Ye.** prof., academician (Belarus)  
**Volkov S.V.** prof., academician (Ukraine)  
**Vorotyntsev M.A.** prof., academician (Russia)  
**Gazaliyev A.M.** prof., academician (Kazakhstan)  
**Yergozhin Ye.Ye.** prof., academician (Kazakhstan)  
**Zharmagambetova A.K.** prof. (Kazakhstan), deputy editor in chief  
**Zhorobekova Sh.Zh.** prof., academician (Kyrgyzstan)  
**Itkulova Sh.S.** prof. (Kazakhstan)  
**Mantashyan A.A.** prof., academician (Armenia)  
**Praliyev K.D.** prof., academician (Kazakhstan)  
**Bayeshov A.B.** prof., academician (Kazakhstan)  
**Burkitbayev M.M.** prof., academician (Kazakhstan)  
**Dzhusipbekov U.Zh.** prof., corr. member (Kazakhstan)  
**Muldakhmetov M.Z.** prof., academician (Kazakhstan)  
**Mansurov Z.A.** prof. (Kazakhstan)  
**Nauryzbayev M.K.** prof. (Kazakhstan)  
**Rudik V.** prof., academician (Moldova)  
**Rakhimov K.D.** prof., academician (Kazakhstan)  
**Streltsov Ye.** prof. (Belarus)  
**Tashimov L.T.** prof., academician (Kazakhstan)  
**Toderash I.** prof., academician (Moldova)  
**Khalikov D.Kh.** prof., academician (Tadjikistan)  
**Farzaliyev V.** prof., academician (Azerbaijan)

**News of the National Academy of Sciences of the Republic of Kazakhstan. Series of chemistry and technology.**  
**ISSN 2518-1491 (Online),**  
**ISSN 2224-5286 (Print)**

Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)

The certificate of registration of a periodic printed publication in the Committee of Information and Archives of the Ministry of Culture and Information of the Republic of Kazakhstan N 10893-Ж, issued 30.04.2010

Periodicity: 6 times a year

Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,  
<http://nauka-nanrk.kz/chemistry-technology.kz>

© National Academy of Sciences of the Republic of Kazakhstan, 2018

Editorial address: Institute of Organic Catalysis and Electrochemistry named after D. V. Sokolsky  
142, Kunayev str., of. 310, Almaty, 050100, tel. 291-62-80, fax 291-57-22,  
e-mail: [orgcat@nursat.kz](mailto:orgcat@nursat.kz)

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

NEWS

OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN

SERIES CHEMISTRY AND TECHNOLOGY

ISSN 2224-5286

<https://doi.org/10.32014/2018.2518-1491.8>

Volume 5, Number 431 (2018), 58 – 66

Zh.A. Kulekeyev<sup>1</sup>, G.K. Nurtayeva<sup>1\*</sup>, E.S. Mustafin<sup>2</sup>, A.A. Ainabayev<sup>2</sup>,  
T.E. Mustafin<sup>2</sup>, A.S. Borsynbayev<sup>2</sup>, G.A. Zharikessov<sup>3</sup>

<sup>1</sup>Scientific-Research Institute of production & drilling technology of «KazMunayGaz» LLP, Astana, Kazakhstan;

<sup>2</sup>Laboratory of the engineering profile «Physico-chemical methods of research» Karaganda State University, Karaganda, Kazakhstan;

<sup>3</sup>North Caspian Operating Company N.V., Atyrau, Kazakhstan

\*e-mail: [gnurtaeva@mail.ru](mailto:gnurtaeva@mail.ru)

## USING HERDERS FOR OIL SPILL RESPONSE IN THE SEA

**Abstract.** The article is devoted to the study of the capabilities, optimal conditions and efficiency of using herders for in-situ burning of oil as an oil spill response technique in the Kazakhstan Sector of the Caspian Sea (KSCS). The in-situ burning of spilled oil is considered as a preferred approach to fight large-scale oil spills offshore, when the oil slick spreads over large distances under the action of wind and currents, which also results in a greater spill area and greater spilled oil volume due to water absorption. Herders, or chemical oil-collectors, are used in the world practice for contracting oil slicks and their thickening before oil combustion. This study was conducted to determine the feasibility of using in the Kazakhstan sector of the Caspian Sea those herding agents that have proven to be effective for other types of oil and other marine conditions. The herding performance, suitability and efficiency of Siltech OP-40 and ThickSlick 6535 herders were investigated for Kashagan oil in artificial sea water with salinity level of KSCS.

**Key words:** oil spill, herders, dispersants, Kashagan, Kazakhstan sector of Caspian Sea, salinity, in-situ burning.

The Kashagan offshore oil field is located in the northern part of the Kazakhstan sector of the Caspian Sea. The distinctive features of the Northern Caspian are low depth of 2-6 m, low salinity of about 6 ‰ and ice cover in winter. Therefore, the methods for oil spills response, developed for open seas with large depth, 33-35 ‰ salinity and minimum fluctuations in water temperature, require significant adaptation to the conditions of the northern part of the Caspian Sea. The above facts necessitate additional studies to select the most suitable methods using chemical agents for oil spill response to find the conditions that provide the greatest positive effect.

Previously, the capability of using dispersants for the oil spills response [1,2] was investigated for Kashagan oil and for the conditions of the northern Caspian [3,4]. Based on the results of these works, the Ministry of Energy of the Republic of Kazakhstan approved the Method for Determination of Dispersants for inclusion on the list of dispersants for the liquidation of oil spills in the sea and inland water bodies of the Republic of Kazakhstan [5]. Also, the Ministry of Energy of the RK approved a list of admissible dispersants, including 5 dispersants [6].

Chemical collectors or herders are surfactants having two ends: hydr and hydrophobic. Herders are designed to contract the oil slick and prevent the oil spreading. The herders are applied to the water surface adjacent to the oil slick, thereby reducing surface tension at the oil/water interface. Reduction of the surface tension of water contributes to the tightening of the oil slick, which in turn leads to an increase in the thickness of the stain to the values sufficiently high for ignition and further combustion of oil.

The possibilities of using herders for oil spill response have been studied since the 1970s, but were considered from the standpoint of their use to restrain oil for subsequent mechanical collection [7,8]. Beginning in 2004, they began to explore more specifically the possibility of using them to contract oil stains before burning oil in cold seawater, especially in ice conditions [8,9].

The principle of the herder action is shown in Fig. 1.

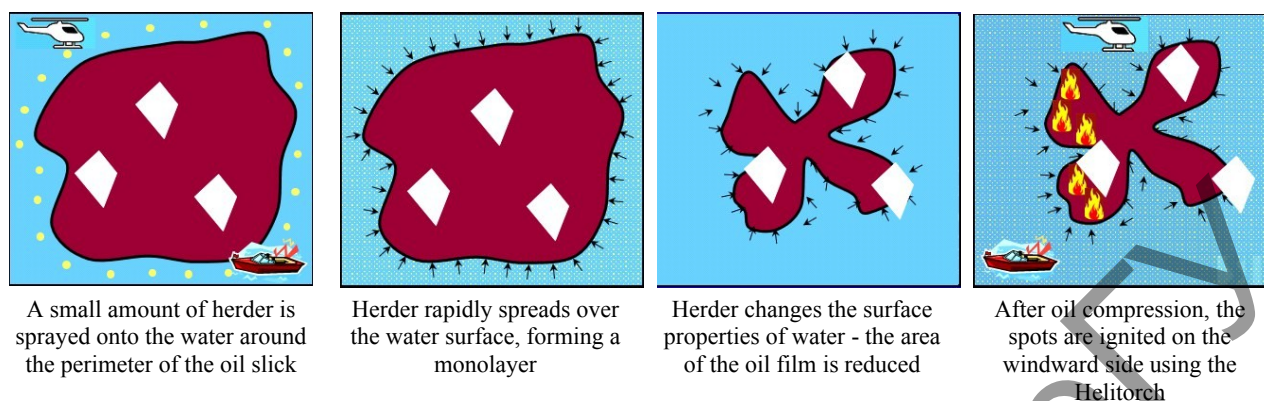


Figure 1 - Effect of the herder on an oil slick [5]

In our opinion, the largest number of effective studies on chemical collectors - herders was conducted by Jan Buist, who developed a technique for small-scale testing of herders [10-12]. Over the past period, he carried out a number of tests to burn different types of oil in various natural and climatic conditions [6-7], including the use of herders, which allowed him to establish their comparative characteristics. The most effective herders, based on the results of the studies of Buist et al., are ThickSlick 6535 and Siltech OP-40. Both these chemical collectors were included in the list of herders allowed for use by the U.S. Environmental Protection Agency and currently, they are the most well-known in the world and commercially available chemicals.

A brief description of these collectors is presented in the following table [8].

Table 1 - Herders for testing on Kashagan oil

Herder	ThickSlick 6535	Siltech OP-40
Indicators		
Manufacturer	Desmi Inc.	Siltech Corp.
Composition	65% sorbitan monolaurate and 35% 2-ethyl butanol	3-(polyoxyethylene)propyl-heptamethyltrisiloxane
Density, $\text{g/cm}^3$ (60 F = 15.6°C)	0.975	0.988
Solubility in water	Partial miscibility	Partial miscibility
pH	6.45	10.1
Kinematic viscosity, cSt	24.70	8.27
Dinamic viscosity, mPa*s (cP)	25.35	8.37
Freezing point	-1,7°C (21,2°F)	-59°C (-74,2°F)
Flash Point	> 82°C (180°F)	> 82°C (180°F)

In this regard, we were interested in studying the behavior of these ThickSlick 6535 and Siltech OP-40 as herders for Kashagan oil in the water of the North Caspian.

#### MATERIALS AND EQUIPMENT

We used crude degassed Kashagan oil, density 0.802 g/ml, viscosity at 15°C 3.02 mPa\*s.

In the initial stage of the study, weathering was carried out at 60°C. The density of oil increased to 0.803 g/ml, the viscosity under those conditions was 3.11 mPa\*s.

For the second stage of the study, it was used oil stripped at a temperature of 200 °C. The density of the oil was 0.865 g/ml, and the viscosity – 22.6 mPa\*s.

The herders are known to act differently on different types of oil. Thus, to establish comparative characteristics, the Buzachi oil with density 0.920 g/ml and viscosity 427.2 mPa\*s was chosen as an alternative variant.

The experimental basin with an area of 1 m<sup>2</sup> was used for research. For each experiment, the pool was tightened with a freshly washed new plastic film, fastening them with large clips over the sides of the pool.

The tests were carried out at water temperatures of 5°C (+/- 2°C), 15°C (+/- 2°C). The water temperature of 5°C was maintained by adding ice pieces to water as needed. The water temperature was measured in the persistent extended tracking mode by using a thermometer.



Figure 2 - Pool for experiments with herders, on the right - a thermometer

Water for experiments with a salinity of 6‰, 12‰, 18‰ was prepared by dissolving sea salt in water.

Quantitative experimental data:

- The water volume of the corresponding salinity is 20 liters;
- Oil volume - 100 ml. The exact mass of oil was measured by weighing the cylinder with oil before and after pouring oil out of the cylinder, and calculating the difference between these two values; the exact value of the volume was calculated from the oil density.

The herder volume was 150 µl (micropipettes were used for sampling). Just as in the case of oil, the exact mass of the herder was determined by the difference between the total and empty micropipettes, and the exact value of the volume was determined from the density.

## EXPERIMENTAL METHOD

We put water in the pool, create the appropriate temperature, pour 100 ml of oil, let the spot spread over the surface of the pool, add 150 µl of herder at the edges of the spot.

### Results of experiments with oil weathered at 60°C

The oil produced from the Kashagan field is very light, quickly spreads over the surface of the water, tending to the edges of the basin, making it difficult to fix the zero point. We had to repeat the experiment several times to introduce the herder in time.

Fig. 3 shows photographs (real and black and white format) characterizing the results of experiments on the use of two types of herders for Kashagan oil, weathered at 60°C, at a temperature of 5°C and a salinity of 6‰.

From Fig. 3 it can be seen that both herders act as oil collectors, since the area of oil spots decreases in all cases. In the course of the test, it was established that the effect of the herder is independent of the salinity of the water. The effectiveness of the action of chemical collectors in these experiments was not very high due to low density of oil. Nevertheless, of the two types studied the OP-40 herder is more effective. In turn, this herder showed the best result at a temperature of 15°C, because it was able to reach the maximum thickness of the oil film.

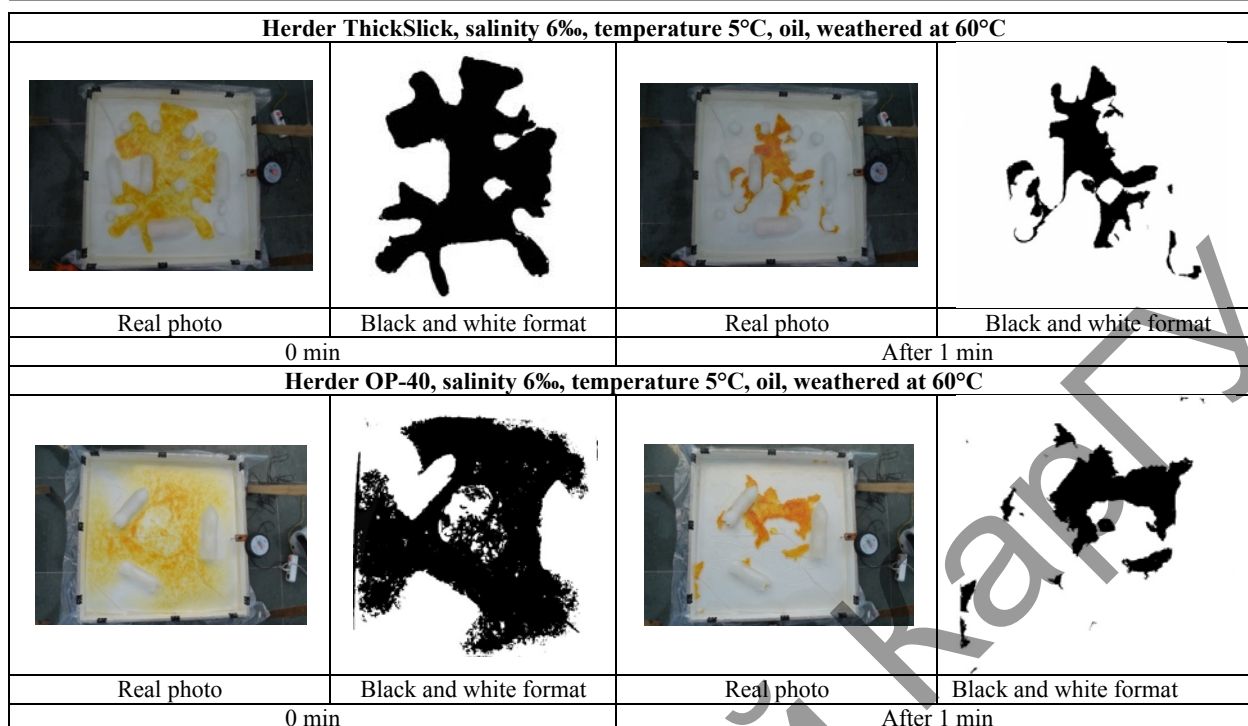


Figure 3 - Images of oil spots before and after the application of two types of herders at a temperature of 5°C and a salinity of 6‰

In Table 2 there are given the results of experiments and their processing on the application of herders to Kashagan oil weathered at 60°C. The areas and thickness of the spots at 15°C calculated are shown.

Table 2 - Experimental and calculated data on the determination of the area and thickness of the spot at 15°C after the application of herders to Kashagan oil weathered at 60°C

#	Test conditions	Number of white pixels	Number of black pixels	Spot area, %	Spot area, cm <sup>2</sup>	Spot thickness, mm
<b>Thick Slick</b>						
1	00 min, 15°C, 6‰ TS	1088629	7625048	0,1249	1249,33	0,8004
2	01 min, 15°C, 6‰ TS	1246566	7349821	0,1450	1450,10	0,6896
3	05 min, 15°C, 6‰ TS	828634	7908811	0,0948	948,37	1,0544
4	30 min, 15°C, 6‰ TS	728408	7962083	0,0838	838,17	1,1931
5	60 min, 15°C, 6‰ TS	703439	7869412	0,0821	820,54	1,2187
6	90 min, 15°C, 6‰ TS	703546	7987086	0,0810	809,55	1,2353
7	120 min, 15°C, 6‰ TS	716835	7926290	0,0829	829,37	1,2057
<b>OP-40</b>						
1	00 min, 15°C, 6‰ OP-40	1425047	7218113	0,1649	1648,76	0,6065
2	01 min, 15°C, 6‰ OP-40	381624	8714547	0,0420	419,54	2,3835
3	05 min, 15°C, 6‰ OP-40	320863	8559331	0,0361	361,32	2,7676
4	30 min, 15°C, 6‰ OP-40	356232	8467190	0,0404	403,73	2,4769
5	60 min, 15°C, 6‰ OP-40	511166	7921378	0,0606	606,18	1,6497
6	90 min, 15°C, 6‰ OP-40	669823	8139010	0,0760	760,40	1,3151
7	120 min, 15°C, 6‰ OP-40	669648	7973795	0,0775	774,75	1,2907

Fig. 4 presents the data characterizing the effectiveness of two herders on Kashagan oil weathered at 60 °C. It is clear that the OP-40 is a more effective herder. It is also seen that after 40 min the activity of the OP-40 herder decreases, while the ThickSlick herder retains this feature for 2 hours.

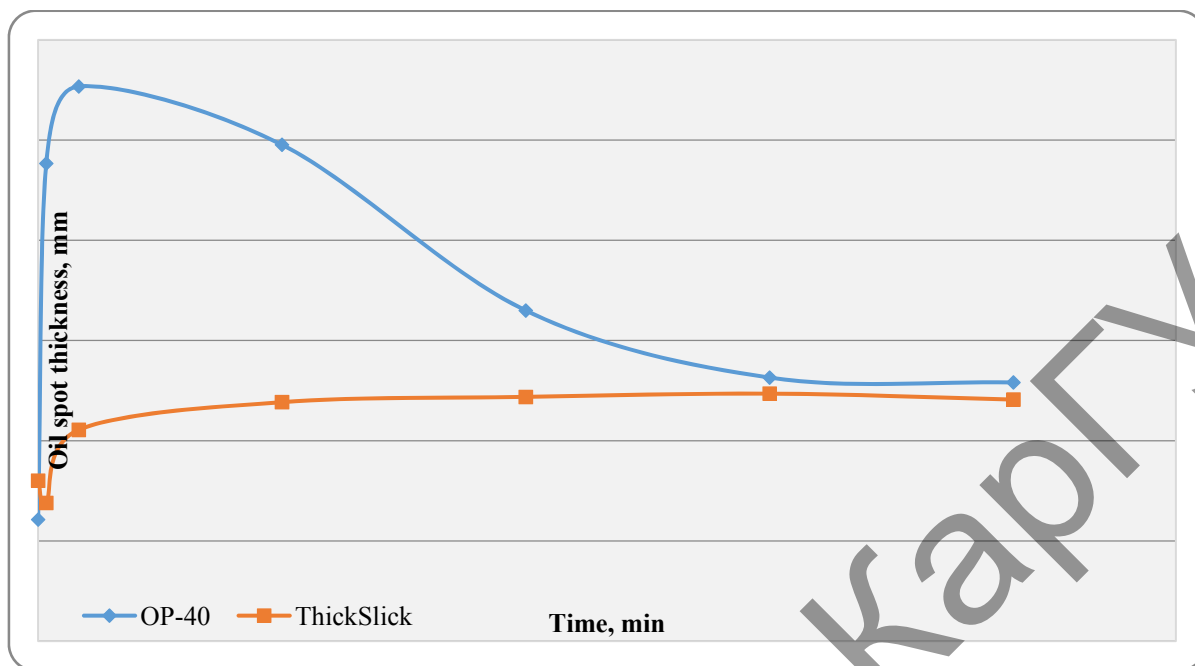


Figure 4 - Efficiency of herders in relation to Kashagan oil weathered at 60°C

### Results of experiments with oil, stripped at 200°C

In real-life conditions, after an oil spill, a certain time passes before the response begins, during which the light fractions can evaporate and the oil becomes more viscous. To bring the experimental data closer to the real conditions, the oil was stripped at 200°C. The oil density increased to 0.865 g/ml, and the viscosity increased to 22.6 mPa\*s.

The results of the herder effect on the oil stripped at 200°C at 5°C are shown in Table. 3.

Table 3 - Experimental and calculated data on the determination of the area and thickness of the spot at 5°C after the application of herders to Kashagan oil stripped at 200°C

#	Test conditions	Number of white pixels	Number of black pixels	Spot area, %	Spot area, cm <sup>2</sup>	Spot thickness, mm
<b>Thick Slick</b>						
1	00 min, 5°C, 6‰ TS	4932840	2747585	0,6423	6422,61	0,1557
2	01 min, 5°C, 6‰ TS	3074019	4786767	0,3911	3910,57	0,2557
3	05 min, 5°C, 6‰ TS	3085968	4956569	0,3837	3837,06	0,2606
4	10 min, 5°C, 6‰ TS	3063227	4664084	0,3964	3964,16	0,2523
5	30 min, 5°C, 6‰ TS	3036094	4758240	0,3895	3895,26	0,2567
6	60 min, 5°C, 6‰ TS	2958613	4592571	0,3918	3918,08	0,2552
7	90 min, 5°C, 6‰ TS	2959968	4901942	0,3765	3764,95	0,2656
<b>OP-40</b>						
1	00 минут, 5°C, 6‰ OP-40	2151907	6627301	0,2451	2451,14	0,4080
2	01 min, 5°C, 6‰ OP-40	1538319	7386747	0,1724	1723,59	0,5802
3	05 min, 5°C, 6‰ OP-40	1199200	7327123	0,1406	1406,47	0,7110
4	10 min, 5°C, 6‰ OP-40	1107462	7552195	0,1279	1278,88	0,7819
5	30 min, 5°C, 6‰ OP-40	1024073	7735862	0,1169	1169,04	0,8554
6	60 min, 5°C, 6‰ OP-40	1022606	7714868	0,1170	1170,37	0,8544
7	90 min, 5°C, 6‰ OP-40	1016577	7767356	0,1157	1157,31	0,8641

Fig. 5 demonstrates the data characterizing the effectiveness of herders at 5°C in relation to Kashagan oil stripped at 200°C. The data show firstly, that the efficiency of the herders quite quickly reaches a peak

(maximum) value; secondly, both herders retain the oil collecting ability for an hour and a half, and thirdly, the OP-40 is more efficient than ThickSlick. In the course of this experiment, the OP-40 herder was able to achieve a maximum thickness of the oil film of 0.85-0.86 mm.

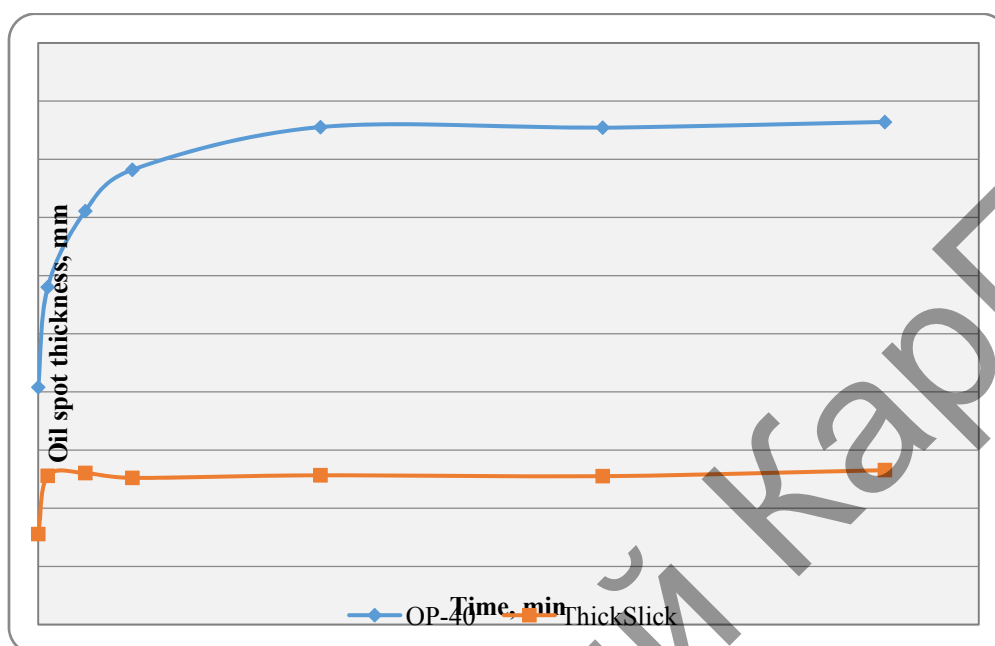


Figure 5 - Efficiency of herders at 5 °C in relation to Kashagan oil stripped at 200 °C

Fig. 6 shows photos describing the effect of the OP-40 herder at 15°C and a salinity of 6‰ on Kashagan oil stripped at 200°C.

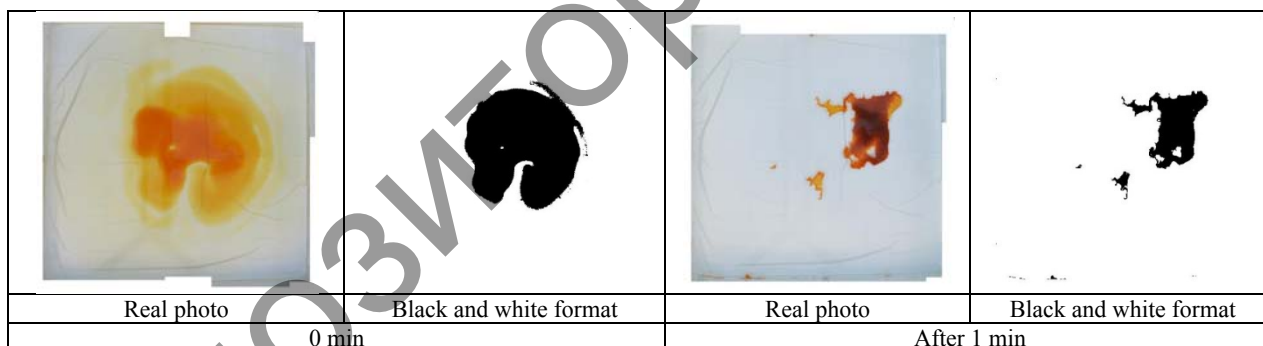


Figure 6 - Photographs and black and white images of oil spots for oil stripped at 200°C: OP-40 herder, 15°C; salinity 6‰

The results of the herder impact on the oil stripped at 200°C at 15°C are shown in Table. 4.

Table 4 - Experimental and calculated data on the determination of the area and thickness of the oil spot at 5°C after herder application to Kashagan oil stripped at 200°C

#	Test conditions	Number of white pixels	Number of black pixels	Spot area, %	Spot area, cm <sup>2</sup>	Spot thickness, mm
1	2	3	4	5	6	7
<b>Thick Slick</b>						
1	00 min, 5°C, 6‰ TS	1711573	7457102	0,1867	1866,76	0,5357
2	01 min, 5°C, 6‰ TS	1212779	7786793	0,1348	1347,60	0,7421
3	05 min, 5°C, 6‰ TS	1227626	7965183	0,1335	1335,42	0,7488

Продолжение таблицы 4						
1	2	3	4	5	6	7
4	10 min, 5°C, 6‰ TS	1018576	8198153	0,1105	1105,14	0,9049
5	30 min, 5°C, 6‰ TS	1237076	7883121	0,1356	1356,41	0,7372
6	60 min, 5°C, 6‰ TS	1003368	8164454	0,1094	1094,45	0,9137
7	90 min, 5°C, 6‰ TS	1013537	7097312	0,1250	1249,61	0,8003
<b>OP-40</b>						
1	00 min, 5°C, 6‰ OP-40	1563154	7531985	0,1719	1718,67	0,5818
2	01 min, 5°C, 6‰ OP-40	369848	8534342	0,0415	415,36	2,4075
3	05 min, 5°C, 6‰ OP-40	272525	8895435	0,0297	297,26	3,3641
4	10 min, 5°C, 6‰ OP-40	271338	8701935	0,0302	302,38	3,3070
5	30 min, 5°C, 6‰ OP-40	271229	8848742	0,0297	297,40	3,3625
6	60 min, 5°C, 6‰ OP-40	272666	8798668	0,0301	300,58	3,3269
7	90 min, 5°C, 6‰ OP-40	275081	8965908	0,0298	297,67	3,3594

Fig. 7 shows the efficiency of the herders when exposed to Kashagan oil stripped at 200°C at 15°C. The nature of the action of the herders in time is approximately the same for both temperatures: the area of the spot decreases and becomes stable for 1.5 - 2 hours, while the thickness of the oil spot increases.

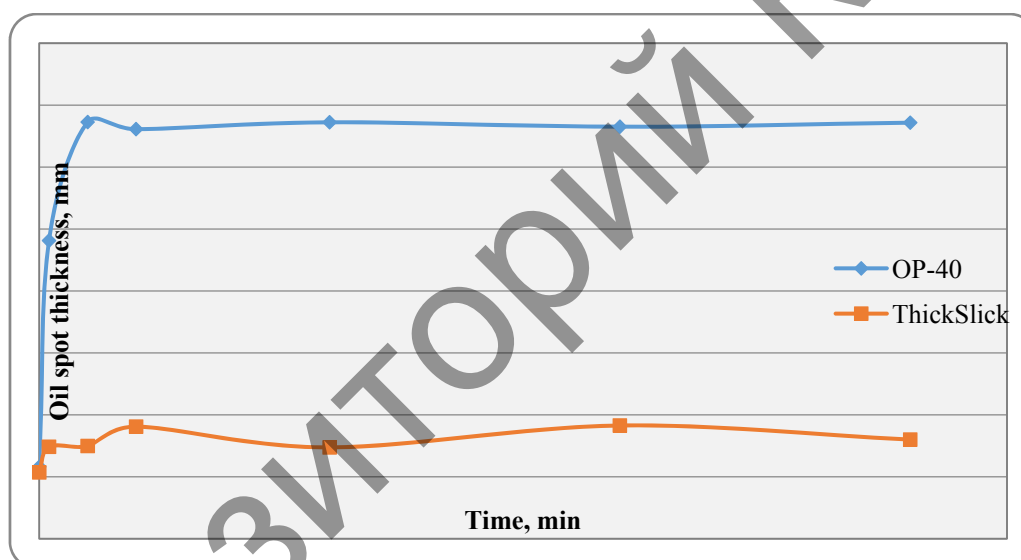


Figure 7 - Efficiency of herders influence at 15 °C to Kashagan oil stripped at 200 °C

With increasing temperature, both herders become more effective. Thus, for the temperature rising from 5 to 15°C the thickness of the oil slick increased from 0.26 to 0.80 mm for Thick Slick herder and from 0.86 to 3.36 mm for OP-40 herder. The effect of water temperature on the effectiveness of herders is shown in Table. 5.

Table 5 - Effect of temperature on the efficiency of herders applied to stripped Kashagan oil

#	Herder	Herder action time, min	Temperature	Spot thickness, mm
1	ThickSlick	60	5°C	0,2552
			15°C	0,9137
2	OP-40	60	5°C	0,8544
			15°C	3,3269

To assess the impact of herders on different types of oil, experiments were conducted with oil from the Buzachi field at 15°C. The results of calculating the efficiency are shown in the Fig. 8. As the data of

this figure show, the efficiency of both herders applied to Buzachi oil is higher as compared to the results of Kashagan oil. Of the two herders, ThickSlick herder in this experiment showed a better result than the OP-40.

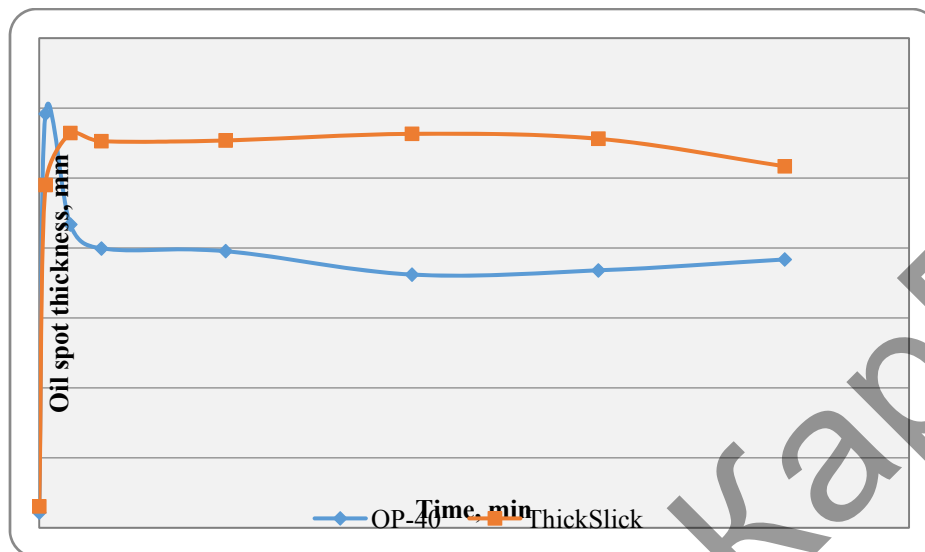


Figure 8 - Efficiency of the herders applied to oil from the Buzachi field at 15°C

## CONCLUSIONS

Thus, the following conclusions are drawn on the basis of the experimental studies :

1. ThickSlick 6535 and Siltech OP-40 herders are effective for contracting and thickening Kashagan oil spot.
2. Herders showed the best result on Kashagan oil, stripped at 200°C: oil density increased to 0.865 g/ml.
3. Of the two herders studied the most effective is Siltech OP-40.
4. The herder's action is independent of the salinity of the seawater.
5. The maximum effect of the herder is reached in 40 minutes. Herders retain their activity for one hour from the time they are applied to the water surface.
6. The efficiency of herders increases with rising temperature.
7. Both herders produce higher impact on Buzachi field oil, which has higher density of 0.920 g/ml and viscosity 427.2 mPa\*s.

## REFERENCES

- [1] Fiocco R.J., Lewis A. (1999) Oil Spill Dispersants. Pure Appl. Chem., 71, 1: 27-42. DOI: 10.1351/pac199971010027.
- [2] Oil Spill Science and Technology. Prevention, Response, and Cleanup (2011). Edit. Fingas M. Elsevier Inc. ISBN: 978-1-85617-943-0.
- [3] Kulekeyev Zh.A., Nurtayeva G.K., Mustafin E.S., Pudov A. M., Zharikessov G., Taylor P., Taylor P.M., Lewis A. (2014) Studies in support of the regulation of dispersant use in the Kazakhstan Sector of the Caspian Sea (KSCS). International Oil Spill Conference Proceedings, 1: 463-475. DOI: 10.7901/2169-3358-2014.1.463.
- [4] Kulekeev Zh.A., Nurtayeva G.K. (2015) Oil spills at sea and methods for their elimination. Almaty, ISBN: 978-601-80189-9-2.
- [5] Method for determination of dispersants for inclusion in the list of dispersants for liquidation of oil spills in the sea and inland water bodies of the Republic of Kazakhstan (2016). Approved by the Minister of Energy of the Republic of Kazakhstan of June 21, 2016, No. 261.
- [6] List of dispersants for liquidation of oil spills in the sea and inland waters (2016). Approved by the Minister of Energy of the Republic of Kazakhstan of June 21, 2016, No. 262.
- [7] Buist I., Cooper D., Trudel K., Fritt-Rasmussen J., Wegeberg S., Gustavson K., Lassen P., Wilson Ulises Rojas A., Jomaas G., Zabilansky L. (2017) Research on using oil herding agents for rapid response in situ burning of oil slicks on open water. Final report for U.S. Department of the Interior Bureau of Safety and Environmental Enforcement Oil Spill Response Research (OSRR) Program Herndon, VA. S.L. Ross Environmental Research Ltd., Ottawa: 1-97. DOI: 10.13140/RG.2.2.36120.70403.
- [8] Buist I., Potter S., Nedwed T., Mullin J. (2011) Herding surfactants to contract and thicken oil spills in pack ice for in situ burning. Elsevier, 7:1-39. DOI: 10.1016/j.coldregions.2011.02.004.

[9] Lane P., Newsom P., Buist I., Nedwed T., Tidwell A., Flagg K. (2012) Recent efforts to develop and commercialize oil herders. Proceedings of the Thirty-five AMOP Technical Seminar in Environmental Contamination and Response, Environment Canada, Ottawa. P.472-479.

[10] Buist I., McCourt J., Potter S., Ross S., Trudel K. (1999) *In situ* burning. Pure Appl. Chem., 71, 1: 43-65. DOI: 10.1351/pac199971010043.

[11] Buist I. Window-of-Opportunity for *In Situ* Burning (2003) Spill Science & Technology Bulletin, 8, 4: 341-346. DOI: 10.1016/S1353-2561(03)00050-1.

[12] Cooper D., Buist I., Potter S., Daling P., Singaas I., Lewis A. (2017) Experiments at Sea with Herders and In Situ Burning (HISB). International Oil Spill Conference Proceedings, 1: 2184-2203. DOI: 10.7901/2169-3358-2017.1.2184.

Ж.Ә. Құлекеев<sup>1</sup>, Г.Қ. Нұртаева<sup>1\*</sup>, Е.С. Мұстафин<sup>2</sup>, А.А. Айнабаев<sup>2</sup>,  
Т.Е. Мұстафин<sup>2</sup>, А.С. Борсынбаев<sup>2</sup>, Г.А. Жарикесов<sup>3</sup>

<sup>1</sup> «Бұрғылау және өндіру технологиялары ҒЗИ» ТШС, Астана қ., Қазақстан;

<sup>2</sup> Қарағанды мемлекеттік университетінің Инженерлік профилдағы «Зертеулердің физика-химиялық әдісі» лабораториясы, Қарағанда қ., Қазақстан

<sup>3</sup> North Caspian Operating Company N.V., Атырау қ., Қазақстан

### ТЕҢІЗГЕ ТӨГІЛГЕН МҰНАЙДЫ ЖОЮДА ХЕРДЕРЛЕРДІ ПАЙДАЛАНУДЫҢ МҮМКІНДІКТЕРІ

**Аннотация:** Бұл зерттеу Каспий теңізінің қазақстандық секторында (КТҚС) мұнай төгілуін жою үшін өртеу әдісін пайдаланған кезде, хердерлерді қолдану мүмкіндіктерін, оңтайлы шарттарын және тиімділігін зерттеуге арналған. Теңізге төгілген мұнайды жоюдың өртеу әдісі теңізде үлкен төгіліс болған жағдайда, жел мен ағын әсерінен мұнай жолағы үлкен қашықтыққа тез тарап, жайылу аймағы және төгілген мұнай көлемі суды сіңіру арқылы айтарлықтай ұлғайған кезде ерекше басымдыққа ие болатын әдіс. Дүниежүзілік тәжірибеде су бетіне төгілген мұнайды өртер алдында жиыстырып, қалыңдығын арттыру үшін хердерлер немесе химиялық жинағыштар пайдаланылады. Зертеу, басқа теңіздер мен мұнайларда жақсы нәтиже көрсеткен хердерлерді Каспий теңізінің қазақстандық секторында пайдалану мүмкіндіктерін анықтау мақсатында жүргізілді. Тұздылығы КТҚС жағдайына сәйкес келетін жасанды теңіз суында қашаған мұнайды үшін Siltech OP-40 және ThickSlick 6535 хердерлерін оңтайлы әрі тиімді пайдалану шарттары анықталды.

**Түйін сөздер:** мұнайдың төгілуі, хердерлер, диспергенттер, Қашаған, Каспий теңізінің қазақстандық секторы, судың тұздылығы, мұнайды өртеу.

УДК 502/504

МРНТИ 87.19.15

Ж.А.Құлекеев<sup>1</sup>, Г.Қ.Нұртаева<sup>1\*</sup>, Е.С.Мұстафин<sup>2</sup>, А.А.Айнабаев<sup>2</sup>,  
Т.Е.Мұстафин<sup>2</sup>, А.С.Борсынбаев<sup>2</sup>, Г.А.Жарикесов<sup>3</sup>

<sup>1</sup> ТОО «НИИ технологий добычи и бурения «КазМунайГаз», г. Астана, Казахстан;

<sup>2</sup> Лаборатория инженерного профиля «Физико-химические методы исследования» Карагандинского государственного университета, г. Караганда, Казахстан;

<sup>3</sup> North Caspian Operating Company N.V., Атырау, Казахстан

### ВОЗМОЖНОСТИ ИСПОЛЬЗОВАНИЯ ХЕРДЕРОВ ПРИ ЛИКВИДАЦИИ РАЗЛИВОВ НЕФТИ НА МОРЕ

**Аннотация:** Исследование посвящено изучению возможностей, оптимальных условий и эффективности применения хердеров при сжигании нефти в качестве метода ликвидации разливов нефти в казахстанском секторе Каспийского моря (КСКМ). Метод сжигания нефти на море является одним из предпочтительных методов в случае больших разливов нефти на море, когда под действием ветра и течений нефтяное пятно быстро распространяется на большие расстояния, при этом значительно увеличиваются и площадь разлива, и объем разлитой нефти вследствие поглощения воды. Хердеры, или химические собиратели, используются в мировой практике для стягивания нефтяного пятна и его утолщения перед проведением сжигания. Исследование проведено с целью определения возможности применения наиболее эффективных, используемых с другими нефтями и в других морских условиях хердеров в условиях казахстанского сектора Каспийского моря. Определены условия и эффективность хердеров Siltech OP-40 и ThickSlick 6535 для кашаганской нефти в искусственной морской воде с соленостью, характерной для КСКМ.

**Ключевые слова:** разлив нефти, хердеры, диспергенты, Кашаган, казахстанский сектор Каспийского моря, соленость воды, сжигание нефти.

#### Information about authors:

Kulekeyev Zh.A. - Scientific-Research Institute of production & drilling technology of «KazMunayGaz» LLP, Astana, Kazakhstan;

Nurtayeva G.K. - Scientific-Research Institute of production & drilling technology of «KazMunayGaz» LLP, Astana, Kazakhstan;

Mustafin E.S. - Laboratory of the engineering profile «Physico-chemical methods of research» Karaganda State University, Karaganda, Kazakhstan;

Ainabayev A.A. - Laboratory of the engineering profile «Physico-chemical methods of research» Karaganda State University, Karaganda, Kazakhstan;

Mustafin T.E. - Laboratory of the engineering profile «Physico-chemical methods of research» Karaganda State University, Karaganda, Kazakhstan;

Borsynbayev A.S. - Laboratory of the engineering profile «Physico-chemical methods of research» Karaganda State University, Karaganda, Kazakhstan;

Zharikessov G.A. - North Caspian Operating Company N.V., Atyrau, Kazakhstan, \*e-mail: [gnurtaeva@mail.ru](mailto:gnurtaeva@mail.ru)

МАЗМҰНЫ

Кантуреева Г.О., Defrancesco E., Алибеков Р.С., Уразбаева К.А., Ефимова И.Е. Қазақстанның дәстүрлі азық-түлік өнімдерді сәйкестендіру жаңа тенденциялары .....	6
Туктин Б.Т., Теңізбаева А.С., Нұрғалиев Н.Н., Шаповалова Л.Б., Яскевич В.И. Модифицирленген Ni(Co)-Mo- Al <sub>2</sub> O <sub>3</sub> катализаторларында тура айдалған бензин фракциясын гидроизомерлеу және гидроөңдеу .....	13
Ахметалимова А.М., Ивасенко С.А., Марченко А.Б., Ишмуратова М.Ю., Ползчак Э., Людвичук А., Посева И.В. Қарағанды өңіріндегі THYMUS EREMITA KLOK. және THYMUS RASITATUS KLOK. өсімдіктерінің химиялық құрамын зерттеу.....	20
Фазылов С.Д., Нұркенов О.А., Журинов М.Ж., Әрінова А.Е., Туктаров А.Р., Исаева А.Ж., Шаихова Б.К. С <sub>60</sub> фуллеренге гидразондардың палладий комплекстерімен катализденетін циклооксидің синтезі .....	26
Опимах Е.В., Левданский А.Э., Голубев В.Г., Корганбаев Б.Н., Сарсенбекулы Д. Ұсақтау барысындағы меншікті энергия шығындарын төмендетудің келешекті бағыттары .....	32
Қасқамет М.Ж., Тәжібаева С.М., Уракаев Ф.Х., Уралбеков Б.М., Бүркімбаев М.М., Бачилова Н.В. Нанокүкіртті алу және тұрақтандыру .....	41
Байсанов С.О., Толоконникова В.В., Нарикбаева Г.И., Корсукова И.Я., Жучков В.И. Күй диаграммасына талдау жасау негізінде марганецті және хромды феррокорытпаларды балқытуға термодинамикалық бағалау.....	47
Құлекеев Ж.Ә., Нұртаева Г.Қ., Мұстафин Е.С., Айнабаев А.А., Мұстафин Т.Е., Борсынбаев А.С., Жарикесов Ф.А. Теңізге төгілген мұнайды жоюда хердерлерді пайдаланудың мүмкіндіктері .....	58
Туктин Б.Т., Нурғалиев Н.Н., Тенизбаева А.С., Шаповалова Л.Б., Комашко Л.В. Бензиннің әртүрлі фракцияларын модифицирленген алюмокобальтмолибден катализаторларында гидрожақсарту .....	67
Қалдыбекова А.Ж., Амангазиева А.Т., Халменова З.Б., Үмбетова А.К. Harpophyllum A. Juss шөбінен биологиялық белсенді заттардың кешенді бөліну технологиясын дамыту .....	74
Опимах Е.В., Левданский А.Э., Волненко А.А., Жумадуллаев Д.К. Флотациялық процесстерді жүргізу әдістері .....	82
Чиркун Д. И., Левданский А. Э., Волненко А.А., Сарсенбекулы Д. Сөккылы-ортдан тепкіш диірмендердегі бөлшектердің динамикасын зерттеу .....	92
Баймұқашева Г.К., Қалауова А.С., Құспанова Б.К., Насиров Р.Н. Үшфенилфосфиннің анион-радикалы.....	102
Баешова А.К., Молайган С., Баешов А.Б. Суутектік энергетиканың қазіргі замандағы жағдайы және суутекті алу әдістері .....	107
Закарина Н.А., Дәлелханұлы О., Жумадуллаев Д.А., Акурпекова А.К., Джумабаева Л.С. Al, AlZr және Ti-мен пилларирленген Na- және Ca-формалы монтмориллонитке енгізілген Pt- және Pd-катализаторларындағы тікелей айдалған бензиннің жеңіл фракциясының изомеризациясы.....	117
Нәсіров Р.Н. ЭПР спектроскопия көмегімен каспий маңындағы мұнайлардағы ванадийді анықтау.....	125
Байжуманова Т.С., Тунгатарова С.А., Xanthopoulos G., Жексенбаева З.Т., Кауменова Г.Н., Еркибаева М.К., Жумабек М., Касымхан К. Метанның олефиндерге дейін каталитикалық конверсиясы.....	132
Калимукашева А.Д., Калиманова Д.Ж., Иманкулова З.А. Формативті бағалау-химия сабақтарында оқыту процесінің ажырамас бөлігі.....	139
Масенова А.Т., Калыкбердиев М.К., Сасе А.С., Кензин Н.Р., Канатбаев Е.Т., Цыганков В.П. Бензин фракцияларындағы хош иісті көмірсутектерді жоғары қысымда отырғызылғын катализаторларды қолдану арқылы суутектендіру.....	146

## СОДЕРЖАНИЕ

<i>Кантуреева Г.О., Defrancesco E., Алибеков Р.С., Уразбаева К.А., Ефимова И.Е.</i> Новые тенденции в идентификации традиционной пищевой продукции Казахстана .....	6
<i>Туктин Б.Т., Тенизбаева А.С., Нурғалиев Н.Н., Шаповалова Л.Б., Яскевич В.И.</i> Исследование гидроочистки и гидроизомеризации прямогонной бензиновой фракции на модифицированных Ni(Co)-Mo- Al <sub>2</sub> O <sub>3</sub> - катализаторах .....	13
<i>Ахметалимова А.М., Ивасенко С.А., Марченко А.Б., Ишмуратова М.Ю., Полезчак Э., Людвичук А., Лосева И.В.</i> Исследование химического состава <i>THYMUS EREMITA KLOK.</i> и <i>THYMUS RASITATUS KLOK.</i> Карагандинского региона .....	20
<i>Фазылов С.Д., Нуркенов О.А., Журинов М.Ж., Аринова А.Е., Туктаров А.Р., Исаева А.Ж., Шахова Б.К.</i> Катализируемое комплексами палладияциклоприсоединение гидразонов к фуллерену C <sub>60</sub> .....	26
<i>Опимах Е.В., Левданский А.Э., Голубев В.Г., Корганбаев Б.Н., Сарсенбекулы Д.</i> Перспективные направления снижения удельных энергозатрат при измельчении .....	32
<i>Кансамет М.Ж., Тажиббаева С.М., Уракаев Ф.Х., Уралбеков Б.М., Буркитбаев М.М., Бачилова Н.В.</i> Получение и стабилизация наносеры .....	41
<i>Байсанов С.О., Толоконникова В.В., Нарикбаева Г.И., Корсукова И.Я., Жучков В.И.</i> Термодинамическая оценка выплавки марганцевых и хромистых ферросплавов на основе анализа их диаграмм состояния .....	47
<i>Кулекеев Ж.А., Нуртаева Г.К., Мустафин Е.С., Айнабаев А.А., Мустафин Т.Е., Борсынбаев А.С., Жарикесов Г.А.</i> Возможности использования хердеров при ликвидации разливов нефти на море .....	58
<i>Туктин Б.Т., Нурғалиев Н.Н., Тенизбаева А.С., Шаповалова Л.Б., Комашко Л.В.</i> Гидрооблагораживание различных бензиновых фракций на модифицированных алюмокобальтмолибденовых катализаторах .....	67
<i>Калдыбекова А.Ж., Амангазиева А.Т., Халменова З.Б., Умбетова А.К.</i> Разработка технологии комплексного выделения биологических активных веществ из растений рода <i>Naplophyllum A. Juss</i> .....	74
<i>Опимах Е.В., Левданский А.Э., Волненко А.А., Жумадуллаев Д.К.</i> Методы проведения флотационных процессов .....	82
<i>Чиркун Д. И., Левданский А. Э., Волненко А.А., Сарсенбекулы Д.</i> Исследование динамики частиц в ударно-центробежных мельницах .....	92
<i>Баймукашева Г.К., Калауова А.С., Куспанова Б.К., Насиров Р.Н.</i> Анион-радикал трифенил-фосфина .....	102
<i>Баешова А.К., Молайган С., Баешов А.Б.</i> Современное состояние водородной энергетики и способы получения водорода .....	107
<i>Закарина Н.А., Дәлелханұлы О., Жумадуллаев Д.А., Акурпекова А.К., Джумабаева Л.С.</i> Изомеризация легкой фракции прямогонного бензина на Pt- и Pd-катализаторах, нанесенных на пилларированный Al, AlZr и Ti монтмориллонит в Na- и Ca-формах .....	117
<i>Насиров Р.Н.</i> Определение ванадия в нефтях прикаспийского региона методом ЭПР-спектроскопии .....	125
<i>Байжуманова Т.С., Тунгатарова С.А., Xanthopoulos G., Жексенбаева З.Т., Кауменова Г.Н., Еркибаева М.К., Жумабек М., Касымхан К.</i> Каталитическая конверсия метана в олефины .....	132
<i>Калимукашева А.Д., Калиманова Д.Ж., Иманкулова З.А.</i> Формативное оценивание - неотъемлемая часть процесса обучения на уроках химии .....	139
<i>Масенова А.Т., Калыкбердиев М.К., Сасе А.С., Кензин Н.Р., Канатбаев Е.Т., Цыганков В.П.</i> Гидрирование ароматических углеводородов в бензиновых фракциях на нанесенных катализаторах под давлением .....	146

CONTENTS

<i>Kantureeva G.O., Defrancesco E., Alibekov R.S., Urazbayeva K.A., Efimova I.E.</i> New trends in the identification of the traditional food products of Kazakhstan .....	6
<i>Tuktin B.T., Tenizbaeva A.S., Nurgaliyev N.N., Shapovalova L.B., Yaskevich V.I.</i> Study of hydro purification and hydroisomerization straight-run gasoline fraction over modified Ni(Co)-Mo- Al <sub>2</sub> O <sub>3</sub> - catalysts .....	13
<i>Akhmetlimova A.M., Ivashenko S.A., Marchenko A.B., Ishmuratova M.Yu., Poleszak E., Ludwiczuk A., Loseva I.V.</i> The study of the chemical composition of <i>THYMUS EREMITA</i> KLOK. and <i>THYMUS RASITATUS</i> KLOK. from the Karaganda region .....	20
<i>Fazylov S.D., Nurkenov O.A., Zhurinov M.Zh., Arinova A.E., Tuktarov A.R., Issayeva A.Zh., Shaihova B.K.</i> Catalyzed by palladium complexes the cycloaddition of hydrazones to fullerene C <sub>60</sub> (in English).....	26
<i>Apimakh Ye.V., Leudanski A.E., Golubev V.G., Korganbayev B.N., Sarsenbekuly D.</i> Promising directions of reducing specific energy costs in grinding (in English).....	32
<i>Kapsamet M.Zh., Tazhibayeva S.M., Urakaev F.Kh., Uralbekov B.M., Burkitbayev M.M., Bachilova N.V.</i> Obtaining and stabilization of nanosulfur .....	41
<i>Baisanov S.O., Tolokonnikova V.V., Narikbayeva G.I., Korsukova I.Ya., Zhuchkov V.I.</i> Thermodynamic assessment of smelting of manganese and chromium ferroalloys based on the analysis of their state diagrams .....	47
<i>Kulekeyev Zh.A., Nurtayeva G.K., Mustafin E.S., Ainabayev A.A., Mustafin T.E., Borsynbayev A.S., Zharikessov G.A.</i> Using herders for oil spill response in the sea .....	58
<i>Tuktin B.T., Nurgaliyev N.N., Tenizbaeva A.S., Shapovalova L.B., Komashko L.V.</i> Hydrotreating of various petrol fractions over modified alumocobaltmolybdenic catalysts .....	67
<i>Kaldybekova A.Zh., Amangazyeva A.T., Halmenova Z.B., Umbetova A.K.</i> Development of technology for the complex isolation of biological active substances from plants of the genus <i>Haplophyllum</i> A. Juss .....	74
<i>Apimakh Ye.V., Leudanski A.E., Volnenko A.A., Zhumadullaev D.K.</i> Methods of carrying out flotation processes .....	82
<i>Chyrkun D.I., Levdanskiy A.E., Volnenko A.A., Sarsenbekuly D.</i> Study of the particle dynamics in impact-centrifugal mills (in English).....	92
<i>Baymukasheva G.K., Kalauova A.S., Kuspanova B., Nasirov R.N.</i> Triphenylphosphine anion radical.....	102
<i>Bayeshova A.K., Molaigan S., Bayeshov A.B.</i> Hydrogen energetics current state and hydrogen production methods.....	107
<i>Zakarina N.A., Dolelkhanyly O., Jumadullaev D.A., Akurpekova A.K., Djumabaeva L.S.</i> Isomerization of light fraction of straight-run gasoline on Pt- and Pd-catalysts supported on pillared by Al, AlZr and Ti montmorillonite in Na- and Ca-forms.....	117
<i>Nasirov R.N.</i> Determination of vanadium in the precaspian region's oil by the EPR-spectroscopy method.....	125
<i>Baizhumanova T.S., Tungatarova S.A., Xanthopoulou G., Zheksenbaeva Z.T., Kaumenova G.N., Erkibaeva M.K., Zhumabek M., Kassymkan K.</i> Catalytic conversion of methane into olefins.....	132
<i>Kalimukasheva A.D., Kalimanova D.Z., Imankulova Z.A.</i> Formative evaluation is an uninterrupted part of the training process on lessons of chemistry.....	139
<i>Massenova A.T., Kalykberdiyev M.K., Sass A.S., Kenzin N.R., Kanatbayev E.T., Tsygankov V.P.</i> Hydrogenation of aromatic hydrocarbons in gasoline fractions over supported catalysts under pressure.....	146

---

**Publication Ethics and Publication Malpractice  
in the journals of the National Academy of Sciences of the Republic of Kazakhstan**

---

For information on Ethics in publishing and Ethical guidelines for journal publication see <http://www.elsevier.com/publishingethics> and <http://www.elsevier.com/journal-authors/ethics>.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see <http://www.elsevier.com/postingpolicy>), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct ([http://publicationethics.org/files/u2/New\\_Code.pdf](http://publicationethics.org/files/u2/New_Code.pdf)). To verify originality, your article may be checked by the Cross Check originality detection service <http://www.elsevier.com/editors/plagdetect>.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации  
в журнале смотреть на сайте:

[www.nauka-nanrk.kz](http://www.nauka-nanrk.kz)

<http://www.chemistry-technology.kz/index.php/ru/>

**ISSN 2518-1491 (Online), ISSN 2224-5286 (Print)**

Редакторы: *М. С. Ахметова, Т. А. Апендиев, Аленов Д.С.*  
Верстка на компьютере *А.М. Кульгинбаевой*

Подписано в печать 11.10.2018.  
Формат 60x881/8. Бумага офсетная. Печать – ризограф.  
9,8 п.л. Тираж 300. Заказ 5.