https://doi.org/10.29013/AJT-23-5.6-36-43

Erkayeva Nazokat Aktamovna,
Doctoral student of Tashkent Institute of Chemical Technology.
Erkayev Aktam Ulashevich,
Doctor of technical sciences,
Professor, Tashkent Institute of Chemical Technology
Kaipbergenov Atabek Tulepbergenovich,
Doctor of technical sciences,
Professor, Director of the Nukus Mining Institute,
Kucharov Bahrom Xayriyevich,
Doctor of technical sciences,
Institute of General and Inorganic Chemistry.
Reimov Karjawbay Dauletbaevich,
doctor of technical sciences (PhD),
associate professor, of Ajiniyaz Institute

INFLUENCE OF THE COMPOSITION ON THE RHEOLOGICAL AND FUNCTIONAL PROPERTIES OF THE COMPOSITION OF LIQUID SYNTHETIC DETERGENTS

Abstract. The optimal conditions for production of synthetic detergents. On the basis of products and local raw materials recommended different formulations of synthetic cleansers.

Keywords: cleaning products, surfactants, sodium hydroxide, sodium carbonate, foaming, corrosion.

The problem of cleaning arises in the most various branches of a national economy that testifies to relevance of this problem.

Efficiency of detergent and quality of cleaning of a metal surface considerably depends on properties of the processed surface – its roughness, sensitivity to corrosive attack of detergent, existence to surfaces of oxides, its uniformity.

The accelerated development of chemical industry allowed to expand in recent years considerably the range of domestic synthetic detergents (SD) and to increase their production.

The analysis of the let-out SD shows that water solutions of the surface-active substances (SAS) and their composition with active additives are more and more applied to degreasing of various surfaces instead of alkalis. Preparations like emulsions and other two-phase systems are practically absent.

Development of production of SD in us in the country has to be directed on creation of alkaline detergents which allow to exclude use of flammable and toxic solvents.

When studying the dependence of the rheological properties of SD, mixtures were prepared that included potassium carbonate, sodium hydroxide, sodium carboxymethyl cellulose (SCC), Trilon B, liquid glass, monoammonium phosphate (MAP), sodium laureth sulfate (SLES), linear alkyl benzene sulfate (LABSA) and water. The initial components were displaced at a temperature of 60 °C and various mass ratios (Table 1).

Table 1.– Mass ratios of the reacting components used for the preparation of SD*

№	K_2CO_3	NaOH	Trilon B,%	Liquid glass	MAP,%	SLES,%	LABSA,%
1	1.896	0.481	2.0	0.856	2.0	10.0	4.0
2	1.871	0.484	2.0	0.846	2.0	5.0	2.0
3	1.870	0.484	2.0	0.846	–	5.0	2.0
4	1.851	0.478	–	0.837	2.0	5.0	2.0
5	1.860	0.479	–	1.178	–	5.0	2.0
6	1.871	0.481	–	1.184	–	10.0	4.0
7	3.450	2.550	1.0	0.836	1.0	5.0	2.0
8	3.460	2.560	–	1.207	–	5.0	2.0

**When receiving the first batch of samples, SLES was used, and the second batch was LABSA*

Samples of the samples belonging to the first batch were synthesized in the presence of SLES, and those of the second batch were synthesized in the presence of LABSA. The composition of samples from batch 1 is significantly different from the composition of the original components. For example, samples 1 and 6 contain twice as much SLES. Sample 3, compared to sample 1, contains less SLES and is characterized by the complete absence of MAP. Samples No. 4–6 contain a relatively large amount of liquid glass, while Trilon B and MAP are absent at all. Samples 7 and 8 contain more and less potassium carbonate and sodium hydroxide, respectively.

Sample samples from Lot 2 differ from Lot 1 in the absence of sodium laureth sulfate. The content of potassium carbonate and sodium hydroxide is in the range of 10.00–18.65% and 8–15%. The content of SD is 1%, which remains unchanged. Similarly, to the sample of batch 1 in batch 2, the amount of liquid glass and MAP varies in the range of 10–12 and 1–2%, respectively.

Experimental data (Table 2) dependence of the density of the samples on the mass ratio of the initial components showed that at a synthesis temperature of 20%, sample 1 has the maximum density when containing a relatively large amount of sodium laureth sulfate. Sample 5, unlike sample 4, does not contain Trilon B and MAP. In contrast to the sample and with a density of 1.2705 g/cm^3, in sample 5, in the absence of Trilon B, the density of the suspension increases to 1.2847 g/cm^3. In this case, it is also necessary to take into account the presence of liquid glass, which contributes to an increase in the density of the sample. Despite the fact that sample 6 contains more water glass than sample 7, its density increases to a value of 1.2900 g/cm^3. Although Trilon B and monoammonium phosphate are absent in sample compared to sample 7, their densities practically do not differ from each other.

The data of Table 2 show that the presence of LABSA in synthetic detergents leads to a decrease in the density of the samples to 1.281 g/cm^3 (Table 2).

Table 2.– The dependence of the density of the synthesized SD on the mass ratio of the initial components and temperature

№	Temperature, °C (batch 1)			Temperature, °C (batch 1)		
	20	40	60	20	40	60
1	*2*	*3*	*4*	*5*	*6*	*7*
1	1.305	1.192	1.160	1.281	1.270	1.263
2	1.290	1.233	1.240	1.284	1.270	1.265
3	1.290	1.278	1.266	1.274	1.266	1.256
4	1.271	1.272	1.258	1.280	1.272	1.265

1	*2*	*3*	*4*	*5*	*6*	*7*
5	1.285	1.265	1.213	1.280	1.278	1.270
6	1.290	1.264	1.267	1.287	1.276	1.266
7	1.275	1.248	1.271	1.256	1.248	1.236
8	1.280	1.270	1.256	1.286	1.262	1.259

Experimental data show that the content of sodium laureth sulfate has the greatest effect on the density of the synthesized SD.

It was also found that with an increase in temperature from 20 °C to 60 °C, the density values of SD samples decrease. For example, the density of sample No. 2 at a temperature of 20 °C is 1.290 g/cm^3, and with an increase in temperature to 60 °C, the density of the sample decreases sharply to a value of 1.160 g/cm^3. A similar pattern is observed for other samples.

An increase in temperature also lowered the values of the viscosity of the SD in the temperature range of 20–60 °C (Table 3). The table shows that, for example, sample No. 2 from the first batch at a temperature of 20 °C has a viscosity of 157.61 cPs. A similar pattern is observed for the SD samples from the second batch, where at 20 °C sample No. 2 shows a viscosity value of 162.65 cPs, and at 60 °C12.04 cPs.

Table 3.– The dependence of the viscosity of the obtained SD on the composition of the initial mixture and temperature

№	Temperature, °C (batch 1)			Temperature, °C (batch 1)		
	20	**40**	**60**	**20**	**40**	**60**
1	95.63	32.87	11.90	140.63	37.75	11.93
2	157.61	63.14	16.11	162.65	43.85	12.04
3	159.66	48.82	15.58	132.45	35.72	13.50
4	157.24	51.09	14.04	169.88	49.47	13.47
5	268.20	42.31	17.54	141.25	35.39	10.57
6	110.11	37.42	10.00	163.27	42.87	19.93
7	283.29	87.87	35.76	180.73	53.04	20.80
8	190.49	61.18	20.72	117.03	41.00	12.64

The composition of the original components also has a significant impact on the viscosity values. According to the chemical analysis in sample 1, compared to sample 2, it contains a relatively large amount of sodium laureth sulfate, as a result of which the viscosity value of this sample decreases. This proves that sodium laureth sulfate reduces the viscosity of the obtained SD. Unlike the others, sample 5 contains a relatively large amount of liquid glass, and the viscosity of this sample at 20 °C is 268.20 cPs, which is significantly higher than in plugs 1–4. Sample 7 is high in potassium carbonate and therefore has a higher viscosity than samples 1–6.

And in sample 6 there is less potassium carbonate and more alkali than in sample 8, i.e. according to the viscosity values, the alkali increases the viscosity of the SD samples.

When analyzing the viscosity values of samples of batch 2, it was revealed that these indicators at 20 °C change in the range from 117.03 to 180.74 cPs. The minimum viscosity value of 117.032 cPs is typical for sample 8, which contains the lowest alkali content and lacks Trilon B. With a decrease in temperature in the SD samples of lot 2, the viscosity value also sharply decreased with decreasing temperature. For example, at a temperature of 20 °C, the viscosity of sample 1 is 140.63 cPs, and with an

increase in temperature to 40 °C, this value decreases by a factor of 3.72.

To study the dependence of the rheological properties of SD samples on temperature and concentration in the laboratory, various concentrations were prepared in the laboratory conditions, solutions of the obtained SD were prepared at different concentrations (Tables 4 and 5).

Table 4. – Dependence of SD density on temperature and concentration

№	Solution, C%	Temperature, °C (batch 1)			Temperature, °C (batch 1)		
		20	40	60	20	40	60
1.1	0.5	1.001	0.994	0.98	1.00	0.99	0.98
1.2	1.0	1.004	0.997	0.99	1.00	0.99	0.99
1.3	2.0	1.007	1.000	0.99	1.00	0.99	0.99
1.4	5.0	1.015	1.010	1.00	1.01	1.00	0.99
1.5	10.0	1.027	1.022	1.01	1.02	1.01	1.00
2.1	0.5	1.001	0.994	0.98	1.00	0.99	0.98

Table data 4 show that at 20 °C a 0.5% solution has a density value of 1.001g/cm^3. With an increase in temperature to 60 °C, the density value decreases to 0.99 g/cm^3. Increasing the concentration of solution 1 to 10% increases the density of the sample to 1.0272 g/cm^3. An increase in the concentration of the solution leads to an increase in the density values. A similar pattern is typical for all SD samples. With an increase in the 0.5% concentration of sample 6 at a temperature of 20 °C to 10%, the density of the solution from 1.06 increases to a value of 1.037 g/cm^3.

Table 5. – Dependence of SD viscosity on concentration and temperature

№	Solution,%	Temperature, °C (batch 1)			Temperature, °C (batch 1)		
		20	40	60	20	40	60
1	0.5	13.90	5.77	2.39	13.20	6.18	2.47
2	1.0	14.63	6.10	2.57	13.84	6.43	2.54
3	2.0	15.42	6.43	2.70	15.26	6.83	2.86
4	5.0	16.04	6.75	2.86	16.21	6.92	2.93
5	10.0	17.30	6.83	2.90	17.30	7.57	3.18

With an increase in the concentration of the solution, its viscosity increases, and this creates difficulties in pumping the solution within the workshop or enterprise. As an example, we can cite the fact of an increase to 17.31 cPs in the viscosity of a solution of 13.9 cPs at a concentration and temperature of 10% and 20 °C, respectively. This is a pattern characteristic of other SD samples. The experimental data of Table 5 show that the samples are practically characterized by the same temperature and concentration, identical viscosity.

To study the effect of SD concentration on pH, solutions of various SD concentrations from the first batch were prepared.

Table 6. – The dependence of pH SD on the concentration of the solution

Solution,%	SD sample numbers from the first batch							
	1	2	3	4	5	6	7	8
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
0.5	10.50	10.51	10.61	10.70	10.50	10.71	10.20	10.70
1	10.65	10.61	10.70	10.81	10.61	10.80	10.40	10.80
2	10.70	10.72	10.81	10.91	10.71	10.92	10.71	10.91

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
5	10.81	10.80	10.90	11.10	10.80	10.41	10.71	11.22
10	10.90	10.91	11.01	11.10	10.90	11.10	10.70	11.30

The data obtained allow us to state that with an increase in the concentration of SD, the pH index increases, which ranges from 10.2 to 11.3. The maximum pH value of the solution is observed in sample 8 with a concentration of 10%. This sample contains an increased amount of potassium carbonate, sodium laureth sulfate and less alkali. Although sample 1 contains an increased amount of sodium laureth sulfate, sample 3 does not contain MAP, and samples 1–3 contain identical amounts of alkali and potassium carbonate, the pH value of the solution varies in the range of 10.5–10.9. Increasing the amount of liquid in sample 5 lowered the pH value.

Next, laboratory experiments were performed to study the foaming ability of SD depending on the ratio of the initial components (Fig. 1 and 2).

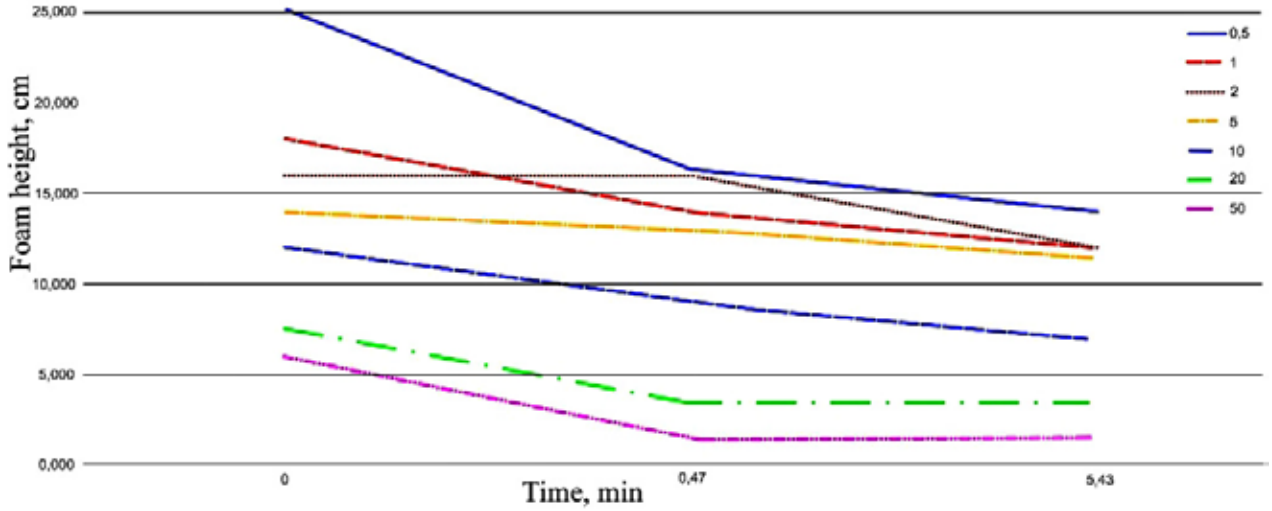

Figure 1. Effect of SD concentration on foaming (1 batch, 1 sample)

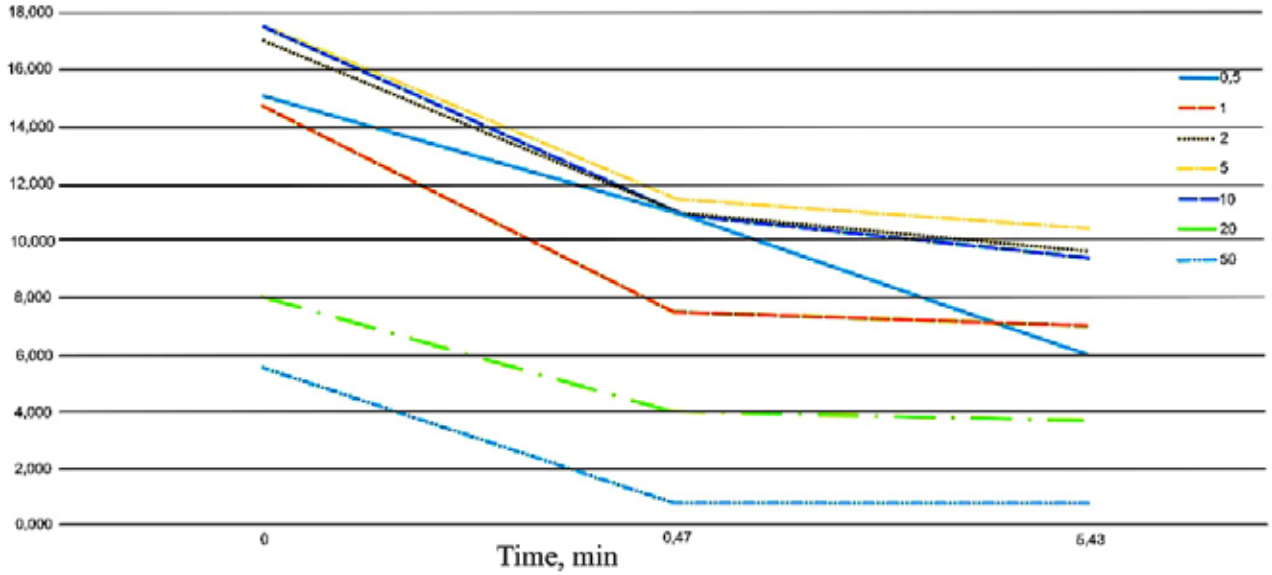

Figure 2. Effect of SD concentration on foaming (1 batch, 5 sample)

As the data in Fig. 1 show, solutions with different ratios of reagents have different foaming abilities. For example, sample 1, which has sodium laureth sulfate in its composition than sample 2, has a greater foaming ability. A solution of this sample at a concentration of 0.5% in the initial period of time forms a foam 25 cm high, while sample 2 at the same concentration forms a foam 9 cm high.

Sample 1 showed high foam resistance, a foam 5 cm high was recorded for 2 days. Sample 2 foam was less stable, since even at a high solution concentration of 5–10%, the foam height was 5 and 10 cm, respectively.

Sample 6 also contains a large amount of sodium laureth sulfate, which forms the maximum foam height in the initial period. The absence of MAP in the samples contributed to an increase in foaming ability.

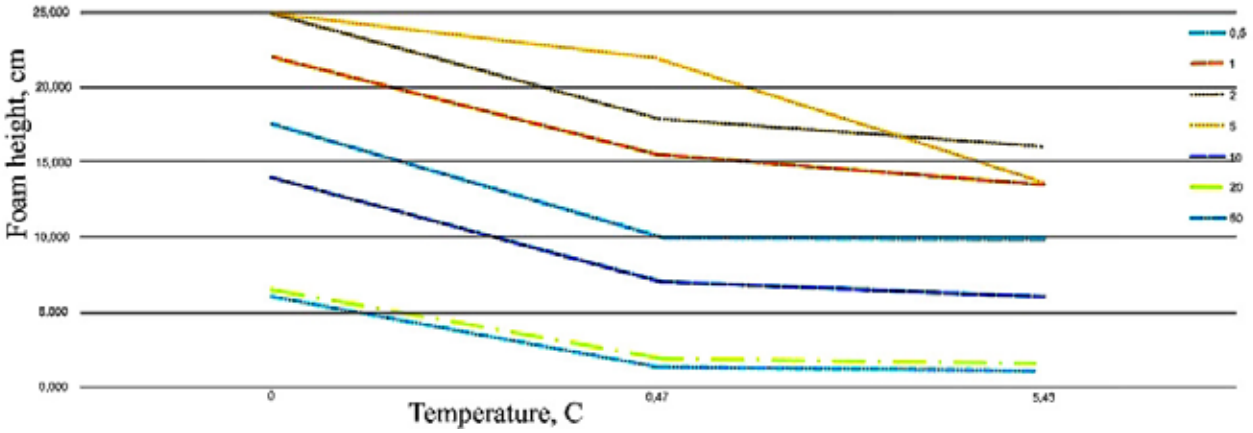

Figure 3. Effect of SD concentration on foaming (batch 2, sample-1)

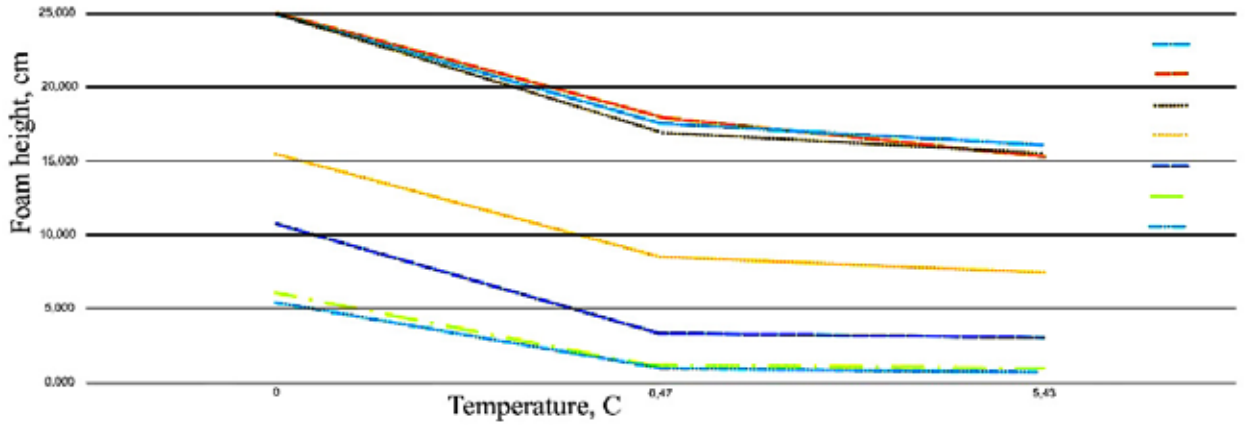

Figure 4. Effect of SD concentration on foaming (batch 2, sample-5)

Experimental data showed that the maximum foam height at the beginning of the process occurs in solutions with a concentration of 1.2% and is 25 cm. In this sample, at the beginning of the process, a foam 25 cm high is formed. Containing in its composition the largest amount of LABSA and liquid glass 0.5; 1; 2; 5% concentration of sample 6 in the initial period of the process formed a large height of stable foam (25 cm).

Due to the above, the technological process of production is simplified and makes it possible to significantly reduce material and energy costs.

Subsequently, solutions of all samples were prepared with a concentration of 0.5; 1 and 2% to study their washing ability.

The results of the research showed that the 2% solution of sample 1 (sample 1.3) had the highest

washing power (48%), and sample 1 of 0.5% concentration had the lowest washing power (20%).

It was found that with an increase in the concentration of the drug from 0.5% to 0.2%, the washing ability increases. For example, sample 2 with a solution concentration of 0.5% has a washing power of 34%. With an increase in concentration to 2%, the washing ability increases to 38% (sample 2.3).

It should be noted that in sample 4.1, the washing power is 24%. At a solution concentration of 2%, a sharp increase in washing power up to 38% is observed (Tables 7 and 8).

Table 7.– The dependence of the washing power of SD concentration (samples from lot 1)*

Sample no.	1.1	1.2	1.3	2.1	2.2	2.3
Washing capacity,%	54	60	62	54	56	58
Sample no.	3.1	3.2	3.3	4.1	4.2	4.3
Washing capacity,%	58	58	68	44	46	58
Sample no.	5.1	5.2	5.3	6.1	6.2	6.3
Washing capacity,%	42	44	44	44	46	48
Sample no.	7.1	7.2	7.3	8.1	8.2	8.3
Washing capacity,%	40	41	54	56	58	60

** – numbers of samples correspond to the numbers of samples in Table 6*

The results of the studies (Table 7) indicate that prepared in the presence of LABSA in SD have a greater detergency than samples of SD obtained in the presence of sodium laureth sulfate. The maximum washing power in these samples was 90%.

Solutions with a concentration of 5% had the best washing ability. For example, a 0.5% solution of the first sample had a washing power of 60%, while in a 5% solution it was 74%. In the absence of Trilon B in sample 4, depending on the concentration, a different change in washing ability was obtained. This sample at a 0.5% solution concentration has a detergency of 58%, and at a concentration of 2%, the detergency reached 72%, which is 14% higher than the detergency value of a 0.5% solution.

Table 8.– The dependence of the cleaning power of SD on the concentration (samples from batch 2) *

Sample no.	1.1	1.2	1.3	2.1	2.2	2.3
Washing capacity,%	60	74	74	70	64	76
Sample no.	3.1	3.2	3.3	4.1	4.2	4.3
Washing capacity,%	60	64	74	58	78	72
Sample no.	5.1	5.2	5.3	6.1	6.2	6.3
Washing capacity,%	80	82	80	84	88	90
Sample no.	7.1	7.2	7.3	8.1	8.2	8.3
Washing capacity,%	52	54	56	58	60	72

** – numbers of samples correspond to the numbers of samples in Table 4*

According to Table 8, sample 6 with a concentration of 2% has the highest detergency. This sample contains a small amount of LABSA in the absence of Trilon B and MAP.

The results of the conducted studies allow us to conclude that with a change in temperature and mass ratios of compounds, it has a significant effect on the density of SD.

A study of the dependence of the foaming ability of SD on the mass ratio of the reacting components showed this solution to have a significant effect on foaming, and the samples differ significantly in this feature.

In the sample containing the largest amount of sodium laureth sulfate, the maximum detergency is observed. In addition, it was found that the samples in the absence of MAP and Trilon B additives also have the best washing ability.

References:

1. Ветошкин Ю. С. Прогнозирование производства и потребления СМС и товаров бытовой химии в России до 2010 г. / Бытовая химия.– № 25. 2007.– 16 с.
2. Anders E. K. Глобальный и Российский рынок СМС. Состояние, развитее, перспективы / Бытовая химия.– № 26. 2007.– 5 с.
3. Бухштаб З. И. Технология синтетических моющих средств / З. И. Бухштаб, А. П. Мельник, В. М. Ковалёв.– М.: Легпромбытиздат, 1988.– 320 с. ISBN5-7088-0365-7
4. Николаев П. В., Петрова Н. А. Основы химии и технология производства синтетических моющих средств.– Иваново, 2007.–405 с.
5. Эркаева Н. А., Шарипова Х. Т., Каипбергенов А. Т., Эркаев А. У., Кучаров Б. Х. Влияние состава моющих композиций на их функциональные показатели. Узбекский химический журнал, – № 3.2019. – С. 76–83.
6. Kaipbergenov A. T., Erkaev A. U., Shadmanov O. Ya., Tairov Z. K. Development of compounding powder cleaners.– Austrian Journal of Technical and Natural Sciences,– № 11–12. 2015.– P. 56–57.
7. Эркаева Н. А., Эркаев А. У., Каипбергенов А. Т. Физико-химические и товарные свойства синтетических моющих средств, полученных на основе сесквикарбоната натрия.– Universum: технические науки,– № 7.– 3(76). 2020.– С. 61–65.
8. Erkayeva N. A., Erkayev A. U., Nurmurodov T. I., Kaipbergenov A. T. A study on the influence of synthetic compositions of liquid detergents on rheological and functional properties.– Chemical Technology, Control and Management,– № 4. 2019.– P. 53–61.