

DOI 10.26886/2520-7474.3(29)2018.2

UDC: 666.942:666.942.4/.7

**INFUENCE OF MINERAL ADDITIVES ON CORROSION RESISTANCE
OF GROUTING MORTARS**

V. Tokarchuk PhD in Technical Sciences, Y. Kovalenko, P. Mazurok
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic
Institute" Ukraine, Kyiv

The influence of mineral highly dispersed additives on the properties and corrosion resistance of grouting mortars was considered. Selected additives: bentonite clay, metakaolin and silica. It was established that when all additives are injected into the oil-well cement, the strength of the last is reduced. The lowest strength was observed in specimens with addition of bentonite clay.

The addition of metakaolin does not reduce the rate of water separation of tampon solutions and for its use it is necessary to add a stabilizing additive. Solutions containing additives bentonite clay and silica conform to requirements of standards for this indicator.

Highest corrosion resistance in cement with silica.

Key words: oil-well cement, bentonite, metakaolin, silica, bleeding, corrosion resistance

Introduction. Extraction of oil and gas is connected with the need to ensure the tightness of the annular space and the separation of layers during cementation of wells. This allows not only to increase the life of wells, but also to increase their productivity.

The basis of grouting mortars is oil-well cement and various additives that allow you to adjust the properties of solutions depending on the conditions of the work.

Unlike the usual, in the oil-well cement the following properties are regulated: bending strength; density, resistance to mineralized reservoir and seawater; high fluidity and regulated periods of hardening, which allows to pump the solution into the well; rapid growth of strength, which prevents the negative impact of the environment on the formation of cement stone [1].

The standard provides the production of three types of oil-well cements: with no additives (type I), with mineral additives (type II), with special additives regulating the density of cement paste (type III).

At the same time, for cement density, cements of type III are divided into: lightweight (light) and weighted (heavy).

Lightweight grouting mortars are generally obtained by increasing the amount of mixing water while simultaneously providing water retention capacity by replacing a part of the binder with a lower density filler or by adding a large volume of the gas forming phase while simultaneously dispersing and stabilizing it [2].

For the first time in foreign practice, clays and clay powders [3], which had an average density of 2300-2600 kg / m³, and added in a quantity of up to 20 mass % by the weight of cement, were used as a facilitating supplement for cementing low temperature wells

With the increase of the content of bentonite clay powder, the time of hardening is increased and the cement strength decreases, which is a disadvantage of such cements and requires a search for the replacement of this component.

Conducting cementing of wells takes place in two stages. At the first stage, the annular space is washed with a drilling mud, and then – it's filling with cement, which should suppress the drilling mud and completely fill the annular space.

In recent years, the depth of drilling has increased and there appears a need to use more fluid solutions. One way of obtaining solutions with such rheological characteristics is to use lightening additives and to inject more water. A significant amount of water leads to the fact that when pushing up along the annular space, the grouting solution loses it, due to filtration in permeable breeds. This leads to a decrease in the mobility of the solution and its untimely hardening. That is why, for such materials takes measures that reduce the water absorption of the solution. Methods may be different for cements [4]: chemical modification of cements, the adding of water-retaining additives, and others.

The purpose of the work is to study the effect of highly dispersed mineral additives on the basic properties of oil-well cements in compare to the addition of bentonite and the effect of these additives on the corrosion resistance of cements.

This requires:

- to study the physical and mechanical properties of oil-well cements with highly dispersed mineral additives and the addition of bentonite;
- determine coefficients of stability of oil-well cements in different types of aggressive solutions.

For researches, mixtures based on the oil-well portland cement of type PC-I-100 type with the addition of appropriate suppressing additives were used. As a control, was selected oil-well cement with the addition of bentonite clay. Cements with mineral additives were investigated: with metakaolin, which is the product of burning of kaolin clay [5, 6] and fine silica, whose chemical activity was previously investigated [7]

The results of determining the strength of cement and cement with additives are shown in Fig. 1

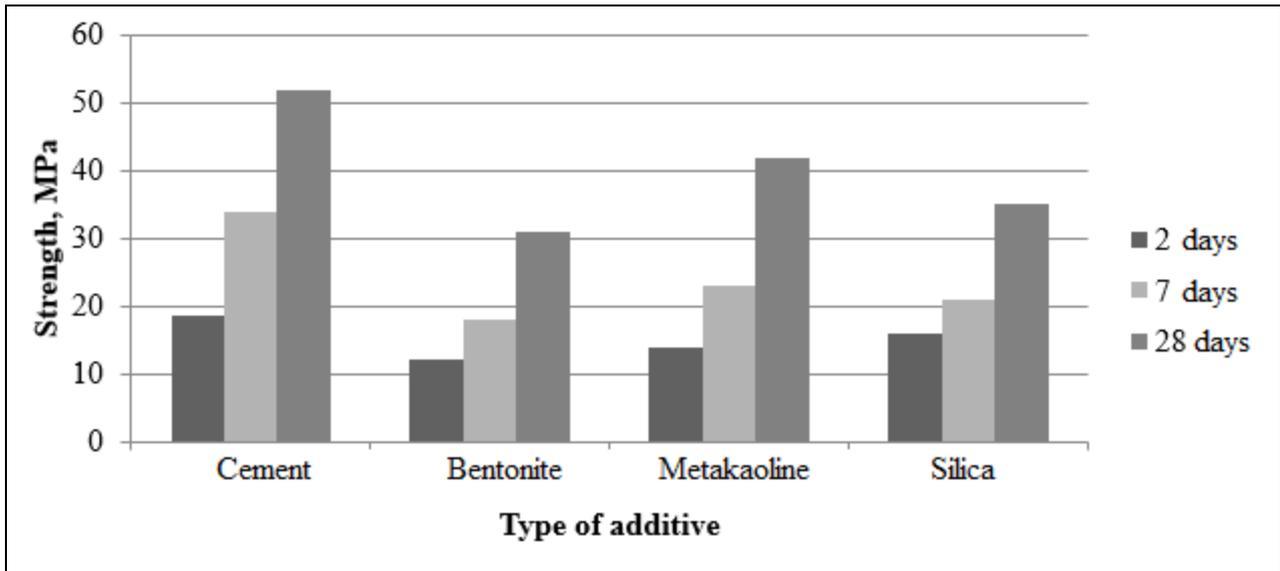


Fig. 1. Strength of cement and cements with 10 mass % of additives

It should be noted that the introduction of 10 mass % of mineral additives leads to a decrease in the strength of the original cement, but samples of cement with the addition of bentonite clay have the lowest rates, and the best - are in cements with the addition of metakaolin.

A similar picture is observed when 20 mass % of mineral additives is added (Fig. 2).

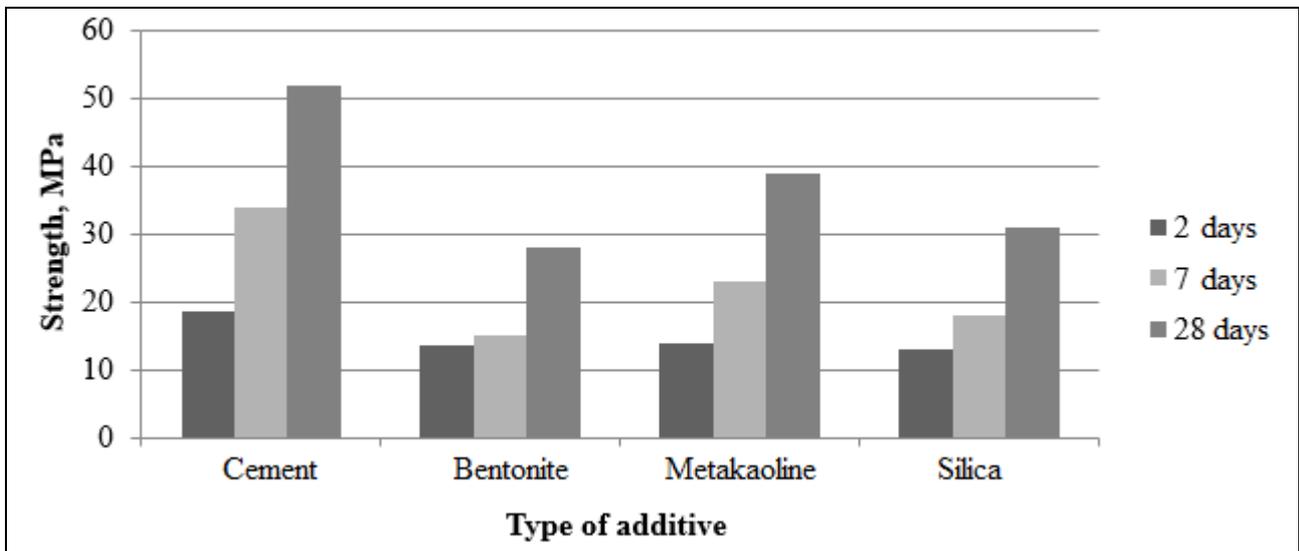


Fig. 2. Strength of cement and cements with 20 mass % of additives

One of the most important indicators of oil-well cements is water separation, therefore the influence of selected additives on this parameter was studied (Table 1).

Table 1

Bleeding of grouting mortars

Additive amount, mass %	Bleeding, mm		
	Bentonite clay	Metakaoline	Silica
10	7	27	6
20	3	26	2

The obtained results indicate that cements with the addition of metaacolin do not allow to obtain solutions that conform to the normative documents. The use of metaacolin, taking into account its positive effect on the strength of the cement stone, is possible with the introduction of additives that stabilize the grouting mortars. In this regard, corrosion resistance was studied only for cements with the addition of bentonite clay and silica.

The corrosion resistance of oil-well cements with additives of bentonite clay (control composition) and microsilica was investigated. Samples were held in aggressive solutions and tap water. The corrosion resistance of cements was determined by the value of the coefficient of stability at the age of 6 months, as the ratio of the strength of the samples, which were kept in aggressive solutions to the strength of samples that were kept in tap water [8]. The results of studies for oil-well cements containing 10% by weight of additives are given in Table 2.

Table 2

Strength of oil-well cements after aging in aggressive environment

Materials n	Concreting terms, days	Compression strength of samples, MPa, after aging in aggressive environments				
		Water	Na ₂ SO ₄	MgSO ₄	CaSO ₄	Seawater
PCT I-100 (oil-well portland cement)	28	25,5	25,5	25,5	25,5	25,5
	60	31,5	23,3	26,5	22,0	17,5
	180	34,0	19,0	19,0	20,0	16,0

PCT I-100 + bentonite clay	28	22,5	22,5	22,5	22,5	22,5
	60	27,0	19,5	23,5	20,0	20,5
	180	28,5	18,1	18,0	18,3	17,3
PCT I-100 + ышскцsilica	28	23,6	23,6	23,6	23,6	23,6
	60	28,3	24.4	26.7	25,5	24,3
	180	30,8	22,3	24,1	27,5	20,0

If we compare the stability of oil-well cements with various reinforcing additives (bentonite clay and microsilica), we can conclude that the addition of silica substantially increases the corrosion resistance of oil-well cement (Fig. 3).

The expediency of using fine silica as a facilitating additive in the production and use of oil-well cements has been proved. This allows to obtain materials of high strength, in comparison with traditional (bentonite clay) and significantly increase the corrosion resistance of such cements.

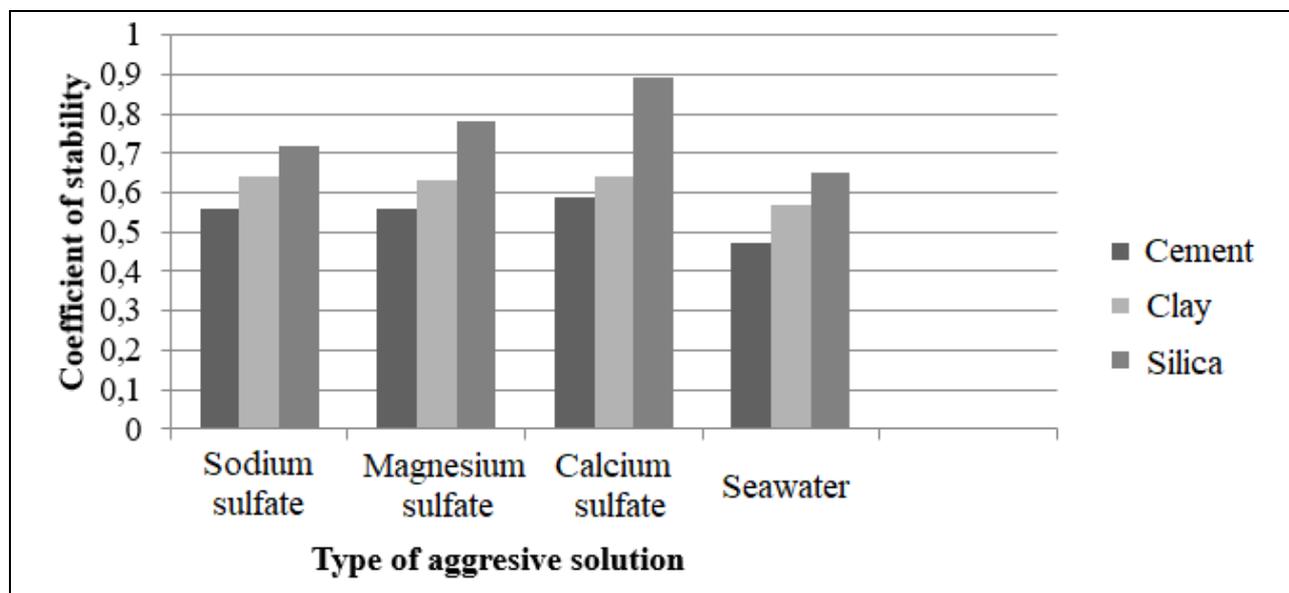


Fig. 3. Coefficient of stability of oil-well cements at age of 6 month

Conclusions

1. The type of mineral additive significantly changes the properties of grouting mortars. There is occurs decreasing in the strength of the

original cement when adding of additives. The smallest index of strength in cements with the addition of bentonite clay, the highest - metaacolin. Introduction of metakaolin does not reduce the water separation of grouting mortars.

2. The corrosion resistance of grouting mortars with the addition of fine silica significantly exceeds this index compare to samples with the addition of bentonite clay.

3. Highly dispersible silicate materials are expedient to use in the manufacture of tin-plate solutions, but this requires additional research in each particular case.

References:

1. *Portlandcementy tamponazhni. Tekhnichni umovy. (GhOST 1581-96): DSTU B V.2.7-88-99. [Chynnyj vid 2000-01-01]. K.: Derzhstandart Ukrainy, 1999. (Nacionaljnyj standart Ukrainy).*
2. *Vyakhirev V. I., Ovchinnikov V. P., Ovchinnikov P. V., Ippolitov V. V., Frolov A. A., Kuznetsov Yu. S., Yankevich V. F., Urosov S. A. Oblegchennye tamponazhnye rastvory dlya krepleniya gazovykh skvazhin. M.: Nedra, 2000. 134 s.*
3. *Batalov D. M. Tsementno-bentonitovyje rastvory dlya nizkotemperaturnykh skvazhin. Tr. ZapSibNIGNI, 1984. S. 56–62.*
4. *Runova R. F., Nosovs'kyj Ju. L. Tekhnologhija modyfikovanykh budivel'nykh rozchyniv. Vydavnyctvo KNUBiA, 2007. 256 s.*
5. *Aiswarya S, Prince Arulraj G, Dilip C "A review on use of metakaolin in concrete" IRACST – Engineering Science and Technology: An International Journal (ESTIJ), Vol.3, No.3, 2013, p. 592 - 597*
6. *Vykorystannja termoobroblenykh sylikatovmishhujuchykh porid pry vyrobnyctvi cementiv ta tamponazhnykh rozchyniv. P. S. Mazurok, M. V.*

Bujun, V. V. Tokarchuk, V. A. Sviderskyj / Tekhnologhycheskyj audyt y rezervy proyzvodstva, 2/4 (28), s. 68-74

7. Special aspects of blended cements hardening with additives with different degree of crystallinity [Online source] / V. V. Tokarchuk, Gh. Ju. Flejsher, V. Ju. Sokoljcov, L. A. Nudchenko // Journal "Scientific review" 3 (35), p. 1 – 12, Access mode:

<http://naukajournal.org/index.php/naukajournal/article/view/1145/1259>

8. Korroziya betona i zhelezobetona i metody ikh zashchity [Tekst]: ucheb./ Moskvin V. M., Ivanov F. M., Alekseev S. N., Guzeev Ye. A. – M.: Stroyizdat, 1980. – 533 s.