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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

# ХАБАРЛАРЫ

# ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

# N E W S

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## ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

**С уважением,**
**Благотворительный Фонд «Халык»!**

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# TECHNOLOGY FOR THE PRODUCTION OF GROUTING CHLORIDE OF A RESISTANT DRILLING MUD BASED ON A SULFUR COMPOSITE MATERIAL

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**Abstract.** In the article, as a solution to the problem of deep drilling in salt-bearing sediments, the use of a grouting chloride-resistant solution based on a sulfur composite material is presented. Sulfur is resistant to aggressive media (solutions of acids and salts), water resistance, which indicates the possibility of obtaining chemically and water-resistant building materials based on it. Modification of silica gel with aluminum chloride was carried out by mixing reagents by heating at various temperatures from 200 to 500°C with the ratio of astringent:filler is 1:1 and 1:1.5. An

increase in the content of aluminum chloride to 5–8 % at a temperature of 200–400°C increases the strength slightly. An increase in the modification temperature above 500°C does not lead to a qualitative improvement in the strength properties of the composition, which is probably due to the sintering of silica gel and a change in its crystal structure. With an increase in the amount of modifying aluminum chloride additive, the water absorption of samples continuously increases at any temperature of preliminary heat treatment. The optimal ratio of binder to filler is 1:1 at a modification temperature of 500°C. Samples prepared according to the proposed formulation with an optimal ratio of components have a high coefficient of resistance to HCl, $H_2SO_4$, $CaCl_2$, NaCl, $MgSO_4$ solutions, high impact strength (52 MPa), frost resistance (240 cycles) and density (1,790 g/cm$^3$).

**Keywords:** drilling mud, grouting chloride resistant solution, sulfur waste, silica gel modification, aluminum chloride

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## КҮКІРТ КОМПОЗИЦИЯЛЫҚ МАТЕРИАЛ НЕГІЗІНДЕ ТАМПОНАЖДЫ ХЛОРИДТІ ТҰРАҚТЫ БҰРҒЫЛАУ ЕРІТІНДІСІН АЛУ ТЕХНОЛОГИЯСЫ

**Аннотация.** Мақалада тұзды шөгінділерде терең бұрғылау мәселесін шешу ретінде күкірт композициялық материалына негізделген хлоридке төзімді ерітіндіні қолдану ұсынылған. Күкірт агрессивті ортаға (қышқылдар мен тұздардың ерітінділері), суға төзімділікке ие, бұл оның негізінде химиялық және суға төзімді құрылыс материалдарын алу мүмкіндігін көрсетеді. Силикагельді алюминий хлоридімен модификациялау тұтқыр:толтырғыш 1:1 және 1:1,5 қатынасында әр түрлі температурада 200-ден 500 °С-қа дейін қыздыру арқылы реагенттерді араластыру арқылы жүзеге асырылды. Алюминий хлоридінің құрамын 200–400 °С температурада 5-8% дейін арттыру беріктікті аздап арттырады. Модификация температурасының 500 °С-тан жоғарылауы композицияның беріктік қасиеттерінің сапалы жақсаруына әкелмейді, бұл силикагельдің агломерациясымен және оның кристалдық құрылымының өзгеруімен байланысты. Алюминий хлоридінің модификациялық қоспасының мөлшерінің ұлғаюымен кез келген алдын ала термиялық өңдеу температурасында үлгілердің суды сіңіруі үздіксіз артады. Тұтқыр мен толтырғыштың оңтайлы қатынасы 500 °С модификация температурасында 1:1 құрайды. Компоненттердің оңтайлы арақатынасында ұсынылған формула бойынша дайындалған үлгілер HCl, $H_2SO_4$, $CaCl_2$, NaCl, $MgSO_4$ ерітінділеріне төзімділіктің жоғары коэффициентіне, жоғары соққы беріктігіне (52 МПа), аязға төзімділікке (240 цикл) және тығыздыққа (1,790 г/см$^3$) ие.

**Түйін сөздер:** бұрғылау ерітіндісі, тампонаж хлориді тұрақты ерітінді, күкірт қалдықтары, силикагель модификациясы, алюминий хлориді

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# ТЕХНОЛОГИЯ ПОЛУЧЕНИЯ ТАМПОНАЖНОГО ХЛОРИДОСТОЙКОГО БУРОВОГО РАСТВОРА НА ОСНОВЕ СЕРНОГО КОМПОЗИЦИОННОГО МАТЕРИАЛА

**Аннотация.** В статье в качестве решения проблемы глубокого бурения в соленосных отложениях представлено использование тампонажного хлоридостойского раствора на основе серного композиционного материала. Сера обладает стойкостью к воздействию агрессивных сред (растворов кислот и солей), водостойкостью, что говорит о возможности получения на ее основе химически и водостойких строительных материалов. Модификацию силикагеля хлоридом алюминия осуществляли смешением реагентов нагреванием при различных температурах от 200 до 500°С при соотношении вяжущее:наполнитель 1:1 и 1:1,5. Увеличение содержания хлорида алюминия до 5–8 % при температуре 200–400 °С повышает прочность незначительно. Повышение температуры модифицирования выше 500 °С не приводит к качественному улучшению прочностных свойств композиции, что связано, по всей видимости, со спеканием силикагеля и изменением ее кристаллической структуры. С увеличением количества модифицирующей добавки хлорида алюминия водопоглощение образцов непрерывно увеличивается при любой температуре предварительной термообработки. Оптимальным соотношением вяжущего к наполнителю является 1:1 при температуре модифицирования 500 °С. Образцы, приготовленные по предлагаемой рецептуре при оптимальном соотношении компонентов, обладают высоким коэффициентом стойкости к растворам HCl, $H_2SO_4$, $CaCl_2$, NaCl, $MgSO_4$, высокой ударной прочностью (52 МПа), морозостойкостью (240 циклов) и плотностью (1,790 г/см$^3$).

**Ключевые слова:** буровой раствор, тампонажный хлоридстойкий раствор, серный композиционный материал, модификация силикагеля, хлорид алюминия.

## Introduction

One of the problems of deep drilling in saline deposits is the creation of salt-resistant drilling fluids. The complexity of developing formulations of these solutions lies in the fact that in natural conditions there are salt deposits (Tauova N. R., et al., 2022), different in composition and properties. In salt complexes, gypsum ($CaS0_4$-$2H_20$), anhydrite ($CaS0_4$), halite (NaCl), sylvin (KCl), carnallite ($KCl\cdot MgCl_2 \cdot 6H_20$), bischofite ($MgCl_2$

· $6H_20$), polyhalite ($K_2Mg\ [Ca_2] \bullet [S0_4]\ 2H_20$), tachydrite are most often found ($2MgCl \cdot CaCl_2 \bullet 12H_20$) (Kanbetov A.Sh., et al., 2023).

Depending on the conditions of formation of chemogenic deposits, salts can occur either in the form of inclusions in sedimentary rocks (Belarus, Eastern Ukraine, Northern Kazakhstan, etc.), or in the form of massifs (Lower Volga region, Western Kazakhstan, etc.) (Seitov et al., 2021). As studies have shown on the study of sandy soils of the Tengiz deposit of the Zhylyoy district of the Atyrau region of the Republic of Kazakhstan, all lithological-facies groups of soils forming an engineering-geological section up to a depth of 20.0 m are extremely saline with a chloride character of salinization (Tauova et al., 2022). All lithological-facies groups of soils also contain carbonates, gypsum and a small amount of organic substances. In terms of sulfate content, for most EGE Portland cements range from non-aggressive to highly aggressive, while for chlorides (Heller et al., 1966), all types of Portland cements are highly aggressive. The main difficulties that arise when conducting wells in salt deposits are caused by the fact that when washing wells, water-based drilling fluids are saturated with salts that cause intense coagulation of clay particles, cavern formation on the walls of the well, collapses of clay layers, plastic flow of reservoir salt. The aggressive effect of salts on drilling mud increases with an increase in downhole temperatures. The temperature difference at different depths of the drilling fluid circulation causes the under-saturation of the solutions at the bottom and their supersaturation as the temperature in the well table decreases. In the upper intervals of wells, supersaturation of solutions is accompanied by the crystallization of salts deposited on the walls of the well and the drilling tool, narrowing the annular space of the trunk and often leading to the seizure of the drilling tool.

In the process of circulation in the well from the bottom to the mouth, the drilling fluid is gradually cooled as a result of heat transfer to the overlying rocks, drilling tools, etc (Kabdushev et al., 2023). When saturated solutions are cooled, crystalline nuclei are released only when the solution is supersaturated with salt. At the same time, in a salt-saturated solution, molecules (ions) continuously combine into large groups; these groups are kinetically unstable and quickly disintegrate if their solubility is higher than the concentration of the electrolyte in the solution.

The crystallization of salts in the drilling mud, in addition to cooling and saturation of the solution with salt, is also caused by the presence of a solid phase in it (drilled rock particles, clay, etc.), on the surface of which the electrolyte is adsorbed (Leonovich et al., 2016). As a result, there is an increased local concentration of the electrolyte up to supersaturation, which causes salt crystallization. Therefore, in solutions with a high content of the solid phase, the crystallization of salts will be greatest. Solutions with a low solid phase content or clay-free systems (polymer solutions, invert emulsions, etc.) are the most promising for maintaining salt equilibrium in the drilling fluid.

The formation of salt crystal growths on the walls of a borehole or drilling tool is subject to the theory of layered crystal growth (Smolyago et al., 2014). Initially, a group of salt ions joins the surface layer of crystals formed on the wall of the well, forming a new energy region of crystallization until the completion of the ionic plane. After the completion of each previous layer of salt, the process is repeated. The rate of formation of such salt growths depends on the force field of its crystal lattice.

The crystallization of salts from the drilling mud in the gutter system and hydraulic strapping of the well causes large salt costs to saturate the solution before pumping it into the well. This leads to salt overruns when drilling wells with flushing with unsaturated solutions, and also causes increased erosion of the walls of the well as a result of their dissolution in an under-saturated solution (*Kemp*, 1987).

In addition, the supersaturation of the drilling mud with one or another salt makes it difficult to chemically treat drilling fluids with protective colloids. At the same time, stabilization liquefaction occurs, accompanied by loss of the structure of the solution, precipitation of the solid phase and the formation of plugs in the well, deterioration of rheological properties and increased water output.

**Materials and methods**

The required amount of dry mixture for the preparation of grouting solution with a given mixture composition, mixing fluid and water-cement ratio is determined by the formula (Zvarygin, 2014):

$$G_{cc} = \frac{V_p}{\sum_{i=1}^{n}\left(\frac{a_i}{p_i}\right) + m\sum_{i=1}^{k}\left(\frac{b_i}{p_i}\right)},$$

where Vp is the volume of the grouting solution; m is the water–solid ratio; $\sum_{i=1}^{n}\left(\frac{a_i}{p_i}\right)$ is the ratio of mass fractions to the density of components in the dry mixture and $\sum_{i=1}^{n}\left(\frac{b_i}{p_i}\right)$ is the ratio of mass fractions of liquid components to their densities. The ratio of the mass fractions of the components of the grouting solution in the dry mixture to their density:

$$\sum_{i=1}^{n}\left(\frac{a_i}{p_i}\right) = \left(\frac{a_1}{p_1}\right) + \left(\frac{a_2}{p_2}\right) +,,, + \left(\frac{a_n}{p_n}\right)$$

where $a_1$, $a_2$, $a_3$, ..., $a_p$ are the mass fractions of the components in the dry mixture; $p_1$, $p_2$, $p_3$, ..., $p_n$ are the densities of the components, t/m$^3$.

The ratio of the mass fractions of the solidification liquid components in grouting solutions to their density will be:

$$\sum_{i=1}^{k}\left(\frac{b_i}{p_i}\right) = \left(\frac{b_1}{p_1}\right) + \left(\frac{b_2}{p_2}\right) +,,, + \left(\frac{b_n}{p_n}\right)$$

where $b_1$, $b_2$, $b_3$, ..., $b_n$ are the mass fractions of the components of the mixing fluid; $p_1$, $p_2$, $p_3$, ..., $p_n$ are the densities of the components in the dry mixture, t/m$^3$.

The required amount of each component of the dry mixture, T.

$$G_1 = a_1 G_{cc}, G_2 = a_2 G_{cc}, \ldots, G_n = a_n G_{cc.}$$

The required amount of the closing fluid of the pancreas $G_f = mG_{cc}$ and the unnecessary amount of components in the closing fluid

$$G_1 = b_1 G_{cc}, G_2 = b_2 G_{cc}, \ldots, G_n = b_k G_{cc.}$$

The density of the grouting solution, t/m$^3$,

$$P_p = (G_{cc} + G_{ff})V_p,$$

and the density of the mixing fluid with additives dissolved in it, t/m$^3$,

$$P = \frac{1}{\sum_{i=1}^{k}\left(\frac{b_i}{p_i}\right)}$$

Then the volume of the sealing fluid, $m^3$, is easily determined from the ratio:

$$V = \frac{G_f}{p_f}$$

For cement mortars intended for colmatation of cracks, the physical parameters of cement are first determined: grade, density, volume weight and fineness of grinding of grouting cement, and then the technological parameters of the cement mortar: density, SNC, viscosity, filtration properties, and only then determine the stability of the solution to the appropriate geological conditions.

The density of the solution is selected in accordance with the reservoir pressure in the well. In wells with abnormally high reservoir pressure (AVPD), weighted cement mortars are used, and vice versa, in wells with abnormally low reservoir pressure (ANDP), lightweight cement mortars are used (Pichor et al., 2018).

Determine the density using devices – a pycnometer and an area meter AG-ZPP.

The most common method for assessing the mobility of grouting solutions is to determine the spreading capacity along the AzNIA cone. Due to its simplicity, this method is firmly rooted in the practice of testing grouting solutions and has replaced the used method of viscosity assessment with the use of a funnel similar to the SPV-5 funnel for measuring the viscosity of drilling fluids, but with a large tube diameter.

**Results**

There is drilling cement that can gain strength in an hour and has increased strength characteristics. For example: PCT II-SS-50. Portland cement grouting sulfate-resistant with mineral additives, for low or normal temperatures. A solution based on it is pumped into the well sufficiently liquid (up to 50 % water), but despite this, it gains high strength with rapid hardening (in 1-2 hours, and finally – during the day) and it gains strength even in water. Crushed clinker and gypsum are added to such cement, as well as special additives that give increased fluidity and strength of the concrete grade up to M600 values. Those who cast gypsum products know that liquid and fluid gypsum mortar quickly gains strength. The same effect is with concrete based on grouting cement. Why, with such properties of this cement, is it not widely used in construction? Firstly, the price. It is much higher than the general construction brands. What distinguishes alumina cement from all others is the ability to harden extremely quickly in air or in water. To achieve this effect, the raw materials are processed in a special way, fired, crushed. Therefore, the raw materials are necessarily soils enriched with aluminum, and they are supplemented with alumina. It is because of the special raw materials that the second name of alumina cement – aluminate – came about. As mentioned above, alumina cement has a much shorter solidification time than other types. This type is grasped within 45 minutes after application. The final solidification takes place after 10 hours. In some cases, there is a need to speed up an already fleeting process. Then gypsum is added to the original composition, obtaining a new variety – the gypsum-alumina variant. It is characterized only by a faster setting and hardening

time while fully maintaining high strength characteristics. Alumina cement is divided into two large groups: expanding and mixed (Umraliev et al., 2019). The peculiarity of expanding is the ability of raw materials to increase during the curing process. The changes will not be noticeable to the eye, but this has a positive effect on the resulting density of the monolithic cement block. The expansion occurs within 0.002–0.005 % of the initial volume. Mixed samples are made mainly in order to reduce the cost and, accordingly, the price of the product, but in some cases, additives provide additional characteristics. For example, gypsum guarantees a higher rate of solidification, while the cost of cement increases. Slags and other active mineral additives, on the contrary, increase the setting time, but the price of such mixed cement is noticeably lower. To reduce the cost, it is possible to use sulfur as a composite material. Kazakhstan is one of the largest producers of elemental sulfur on the world market (Tengizchevroil LLP, 2019). It is mainly obtained as a by-product after separation of high-sulfur oil, is one of the most common chemical elements in nature in the form of organic and inorganic compounds, and is constantly present in all living organisms. In the solid state, sulfur is relatively inert. When heated, it becomes chemically active, reacts with halides (except iodine), does not combine with hydrogen under normal conditions. With metals, sulfur forms sulfide and polysulfide. The properties of solid sulfur and its melt make it possible to use it as a binder for the preparation of mastics, concretes, as well as an impregnating material. Sulfur is resistant to aggressive media (solutions of acids and salts), water resistance, radiation resistance, which indicates the possibility of obtaining chemically and water-resistant building materials based on it (Yessenamanova, 2020). Modification of silica gel with aluminum chloride contributes to an increase in the active centers of the silica gel surface and the opening of sulfur rings.

The creation of a dense and strong structure is due to the formation of stable short S–S bonds in oxygen and silicon during prolonged heating and stirring.

Preparation of SCM (sulfur-composite material) (Yessenamanova et al., 2011) samples using aluminum chloride was carried out in two stages. Initially, the silica gel was modified with aluminum chloride by mixing reagents during heating (200–500 °C), and then the modified silica gel was introduced into the sulfur melt. As can be seen from Figure 1, the dependence of the strength of the samples on the amount of $AlCl_3$ modifying additive is extreme. The best values of compressive strength have samples after preliminary calcination at 500°C and with an aluminum chloride content equal to 5 % by weight (Yusupova et al., 2018). The strength of the composition of such a composition is 70 MPa.

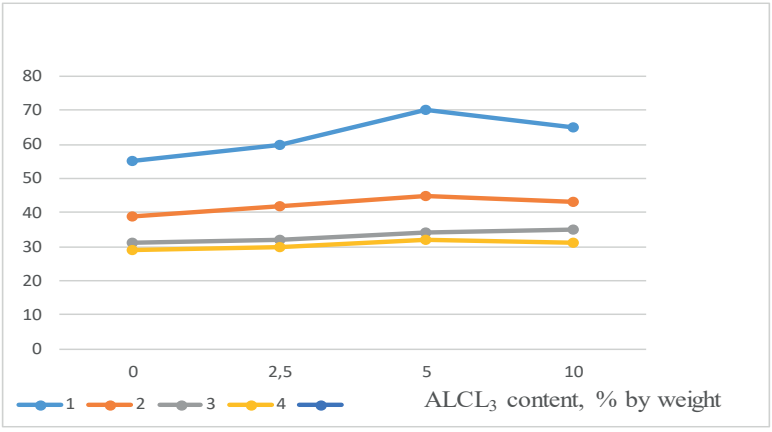


Figure 1. The dependence of the compressive strength of samples of sulfur compositions on the content of aluminum chloride at different temperatures of preliminary heat treatment: 1–500 °C; 2–400°C; 3–300 °C; 4–200 °C. The ratio of astringent:filler is 1:1.

An increase in the content of aluminum chloride to 5–8 % at a temperature of 200–400 °C increases the strength slightly. An increase in the modification temperature above 500 °C does not lead to a qualitative improvement in the strength properties of the composition, which is probably due to the sintering of silica gel and a change in its crystal structure.

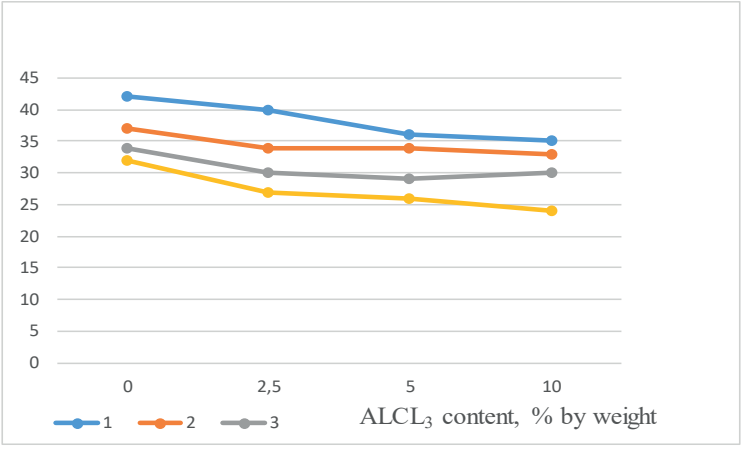


Figure 2. The dependence of the compressive strength of samples of sulfur compositions on the content of aluminum chloride at different pre-calcination temperatures: 1–500 °C; 2–400 °C; 3–300 °C; 4–200 °C. The ratio of astringent:filler is 1:1.5.

Probably, modification of silica gel with aluminum chloride at low temperatures is not carried out or does not occur fully and a sufficient number of electrophilic sulfur activation centers are not formed on the surface of the silica gel.

The aluminum chloride content of -5 % by weight and the modification temperature

of 500 °C, we believe, are optimal conditions for activating the silica gel surface, and can significantly increase the strength of compositions with this binder: filler ratio. With an increase in the filler content (ratio 1:1.5), a decrease in the strength of the sulfur composition is observed (Fig. 2), which is mainly due to the lack of binder. The maximum strength of the samples does not exceed 42 MPa. With an increase in the amount of loose modifying additive, the strength of the samples continuously decreases at any temperature of preliminary heat treatment (Yesenamanova et al., 2011).

The analysis of Figures 1 and 2 shows that the samples have the maximum strength at a ratio of binder: filler – 1:1 and is 70 MPa. The optimal modification time is 30 minutes (500°C).

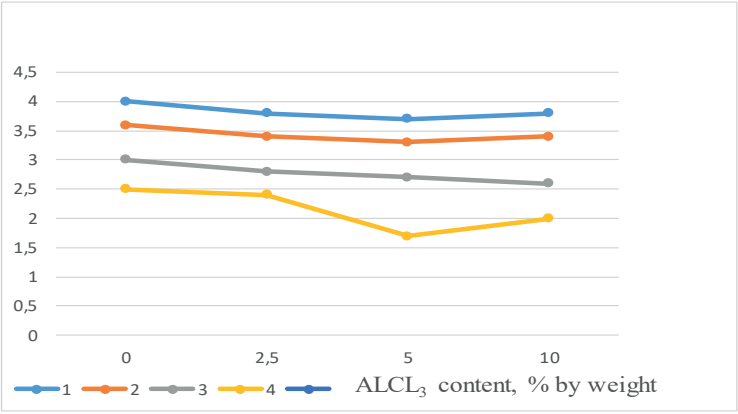


Figure 3. Dependence of water absorption of samples of sulfur compositions on the content of aluminum chloride at different pre-calcination temperatures: 1–200 °C; 2–300 °C; 3–400 °C; 4–500 °C. The ratio of astringent:filler is 1:1.

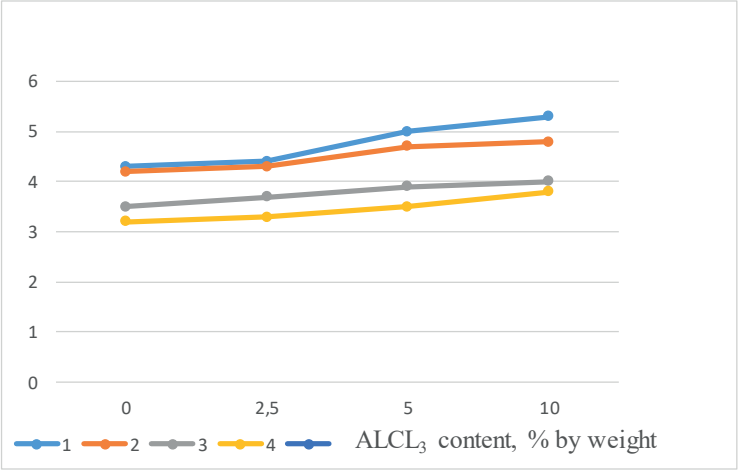


Figure 4. Dependence of water absorption of samples of sulfur compositions on the content of aluminum chloride at different pre-calcination temperatures: 1–200 °C; 2–300 °C; 3–400 °C; 4–500 °C. The ratio of astringent:filler is 1:1.5.

The dependence of the water absorption of the obtained samples on the content of aluminum chloride in the binder and the modification temperature at different binder: filler ratios are shown in Figures 3 and 4.

It can be assumed that the "molecular sorption" of aluminum chloride, which has a vacant d-level, is the basis for the activation and binding of sulfur on the surface of silica gel to form a monolayer. The formation of a nonporous dense structure under these conditions leads to a decrease in the sorption properties of silica gel.

Increasing the modifying additive to 15 % at this temperature increases the water absorption of samples by 40%. Probably, the excess of the modifying additive leads to loosening of the structure of the samples.

Reducing the modification temperature to 200 °C also increases the water absorption of samples (up to 4 %). It is possible that the modification of silica gel at low temperatures is not fully carried out and chemically unrelated aluminum chloride, which has high hygroscopicity, loosens the structure of the samples.

The dependence of water absorption of samples of sulfur compositions with a binder: filler ratio equal to 1:1.5 has a slightly different character (Figure 4).

With an increase in the amount of modifying aluminum chloride additive, the water absorption of samples continuously increases at any temperature of preliminary heat treatment. Moreover, even the initial samples without the addition of aluminum chloride do not meet the requirements of the state standard (ST RK 1261–2004, 2004). The lack of binder, and consequently, the loose structure of the samples and the formation of voids in it can explain this. Since samples of the optimal composition were selected, further tests were carried out for the best samples.

Table 1 presents the results of physical and mechanical tests of samples obtained under optimal conditions with an aluminum chloride content of -5 % by weight.

As can be seen from the table, the samples prepared according to the proposed formulation with an optimal ratio of components have a high coefficient of resistance to HCl, $H_2SO_4$, $CaCl_2$, NaCl, $MgSO_4$ solutions, high impact strength (52 MPa), frost resistance (240 cycles) and density (1,790 g / $cm^3$).

With the dense contact of modified silica gel, filler and sulfur, i.e. during heating and subsequent pressing, it is possible to form new chemical interatomic bonds and the appearance of physical interfacial interaction forces that ensure optimal structure formation in the system at the micro and macro levels.

Table 1 - Physical-mechanical and operational parameters of sulfur composite material ($AlCl_3$ – 5 % by weight)

| The ratio of binder to filler, mass. | Modification temperature, T°C | Sample density, г/см$^3$ | Frost resistance, number of cycles | Water absorption % by weight | Impact strength, MPa | Resistance coefficient | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 5 % HCl | 5 % $H_2SO_4$ | 5 % $CaCl_2$ | 5 % NaCl | 5 % $MgSO_4$ |
| 1:1 | 400 | 1,786 | 230 | 2,80 | 36 | 0,967 | 0,952 | 0,965 | 0,979 | 0,965 |
| 1:1,5 | 400 | 1,660 | 190 | 3,98 | 25 | 0,932 | 0,922 | 0,930 | 0,935 | 0,931 |
| 1:1 | 500 | 1,790 | 240 | 2,32 | 52 | 0,972 | 0,963 | 0,969 | 0,983 | 0,968 |
| 1:1,5 | 500 | 1.730 | 200 | 3,58 | 27 | 0,936 | 0,927 | 0,934 | 0,938 | 0,935 |

**Conclusion**

When drilling deep in saline deposits, it is necessary to use salt-resistant drilling fluids. The use of chloride-resistant drilling fluids is relevant for the Tengiz deposit (Collins et al., 2014), which is characterized by an increased content of chlorides. Among all drilling cements of grouting mortar, alumina cement is capable of extremely rapid solidification in air or in water. The use of sulfur as a component of a sulfur composite material with high strength properties and resistance to aggressive environments could solve the problem of supersaturation of drilling mud with salt. To form these properties of materials, it is necessary to ensure the chemical binding of sulfur with other components. It is established that when using electrophilic and nucleophilic modifiers, the interaction of components is intensified as a result of the formation of active centers in the surface layer of amorphous silica. In the case of aluminum chloride, the process of interaction of sulfur with silica-containing components takes place without activation. Physical and mechanical tests have established that the developed materials have high mechanical properties, resistance to aggressive media such as chloride salts. It is shown that the resulting compounds have high binding energies, i.e. they are stable compounds. The optimal ratio of binder to filler is 1:1 at a modification temperature of 500 °C.

**REFERENCES**

Heller L., *Ben-Yair* M. (1966). Effect of chloride solutions on portland cement. *Journal of Applied Chemistry*, — 16(8): — 223–226. — *https://doi.org/10.1002/jctb.5010160802*

Kabdushev A.A., Agzamov F.A., Manapbayev B.Zh., Delikesheva D.N., Korgasbekov D.R. (2023). Research and development of cements with differential properties for completing gas wells. // News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences,— 4 (460): — 97–108.

Kanbetov A.Sh., Muldakhmetov M.Z., Kulbatyrov D.K., Duisekenova R.G., Dyussengaliyeva G.S., Zhaksiyeva G.R. (2023). Soil condition studies in the area of the Tengiz deposit. // News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, — 5 (461): — 145–155.

*Kemp* N.P. (1987). Mutual Solubility of Salts in Drilling and Completion Fluids. // SPE Annual Technical Conference and Exhibition,— Dallas, — Texas, — SPE-16688-MS. — *https://doi.org/10.2118/16688-MS*

Leonovich S.N., Stepanova A.V. (2016). Modeling of chloride aggression on high-quality concrete for providing esti- mated useful life. Sistemnye tekhnologii. — No. 2 (19); — 75–85. (In Russ.).

ST RK 1261–2004 (2004). Oil and gas industry. Materials for the preparation of drilling mud. Technical requirements and tests. Ministry of Industry and Trade of the Republic of Kazakhstan.

Tauova N.R., Yessenamanova M., Kossarbay K., Yessenamanova Zh., Tlepbergenova A., Shamshedenova S., Batyrbayeva G., Maden S. (2022). Chemical Analysis of Groundwater and Wastewater in the Area of the Tengiz Deposit of the Atyrau Region of the Republic of Kazakhstan. // International Journal of Design and Nature and Ecodynamics,— 17(5): — 691–700.

Tauova N., Yessenamanova M.S., Kozhakhmet K., Kushakov A.R., Kaliyeva A. (2022). Geological state of the stratigraphic complex of the Tengiz deposit. // News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences, — 5: — 249–265.

Seitov N., Kozhakhmet K. (2021). Asthenosphere as an intermediary between the planet's endogenous activity and the tectonic and magnetic activity of its lithosphere. //News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. — 6(450): — 118–124. — *https://doi.org/10.32014/2021.2518-170X.127*. — UDC 551.241. — IRSTI 38.17.01

Smolyago G.A., Kryuchkov A.A., Drokin S.V., Dronov A.V. (2014). Research of aspects of chloride corrosion of steel concrete designs. // V.G. Shukhov Bulletin of the Belgorod State Technological University. — No. 2; — 22–24. (In Russ.)

Tengizchevroil LLP (2019). North and East Ring Project. // Geotechnical investigation report.

Umraliev B.T., Taskinbayev M.J., Seitov A.K., Ashimov K.B., Konuspaev T.M. (2019). The experience of cementing well No. 205 at the Zholamanov field using a lightweight cement mortar with an aluminosilicate additive. // Bulletin of the oil and gas industry of Kazakhstan, — 1(1): — 103–111. (In Russ.)

Pichor W., Kaminski A., Szołdra P., Frac M. (2018). Lightweight Cement Mortars with Granulated Foam Glass and Waste Perlite Addition. // Hindawi Advances in Civil Engineering, — 1705490. — https://doi.org/10.1155/2019/1705490

Yessenamanova Zh.S. (2011). Development of technology for obtaining composite materials by vibrating with a load by analogy with the factory technology of cement concretes. // Journal: Bulletin of KazNTU, — 4(86): — 70–72.

Yesenamanova Zh.S., Nurkeev S.S., Akhmedzhanov T.K., Yesenamanova M.S., Nuranbayeva B.M. (2011). Comparative characteristics of the production of sulfur composite materials using ash and slag waste and the introduction of an aluminum chloride modifier. // Journal: Bulletin of KazNTU, — Almaty. — 4: — 199–201.

Yessenamanova M.S. (2020). Assessment of individual risk criteria for the disposal of radioactive waste. // IOP Conference Series: Materials Science and Engineering. — 734(1), — 012169.

Yusupova A.A., Khatsrinov A.I., Akhmetova R.T. (2018). Activating Effect of Aluminum Chloride in the Preparation of Sulfur Concrete from Sulfur and Silica. // Inorganic Materials. — 54: — 809–814.

Zvarygin V.I. (2014). Grouting mixtures. // Krasnoyarsk, Siberian Federal University, — 18–20.

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