ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

Volume 9
Issue 3
2024

UDK: 691.35.2; 661.7

CORROSION RESISTANCE OF MODIFIED SULFUR CONCRETE IN VARIOUS AGGRESSIVE ENVIRONMENTS

AMANOVA NODIRA

Doctoral student of Termez State University, Termez, Uzbekistan
Phone.: (0890) 520-0176, E-mail.: amanova0176@gmail.com
**Corresponding author*

TURAEV KHAYIT

Professor of Termez State University, Termez, Uzbekistan
E-mail.: hhturaev@rambler.ru

BEKNAZAROV KHASAN

Professor of Tashkent Scientific Research Institute of Chemical Technology, Tashkent, Uzbekistan
E-mail.: amanova0176@gmail.com

SOTTIKULOV ELYOR

Doctoral student of Tashkent Scientific Research Institute of Chemical Technology, Tashkent, Uzbekistan
E-mail.: amanova0176@gmail.com

MAKHMUDOVA YULDUZ

Student of National University of Uzbekistan named after M. Ulugbek, Tashkent, Uzbekistan
E-mail.: amanova0176@gmail.com

Abstract: In this article, it was considered expedient to obtain sulfur concrete based on organic compounds. Silico-PB(siliko-polibutadien) and PEM(poliefirmaleinat) were used as modifiers. The corrosion resistance of the obtained samples of sulfur concrete was studied in aggressive environments, including: 10% solutions of acids H2SO4, HCl, HNO3, H3PO4, 3% solutions of Na2SO4, NaCl, NaF, 10% NaOH, pH=4-10 and machine oil, dichloroethane and diesel fuels. The results obtained in the course of research show an increase in corrosion resistance and an improvement in the mechanical properties of sulfur concrete.

Keywords: sulfur concrete, modification, copolymer, corrosion, aggressive environment.

Introduction. Sulfur-based concrete is a great innovation in construction materials, significantly different from traditional cement-based concrete, which is mainly composed of sulfur, a by-product of industrial processes, replacing traditional concrete due to its sulfur-binding properties. appeared as a tool. One of the main properties of sulfur-based concrete is its ability to harden quickly without the need for water, which is especially useful in dry conditions or in situations where water is scarce. However, despite its useful properties, sulfur-based concrete has limitations, especially in terms of environmental durability [1 -2]. However, despite its beneficial properties, these problems have led to the introduction of modified sulfur-based concrete. Adding small amounts of fillers to the modified sulfur binder improves the strength, durability, and environmental conditions such as temperature changes and chemical exposure. increases resistance to environmental factors. The logical basis of these modifications comes from the need to expand the use of sulfur concrete, eliminating its specific disadvantages. For example, unmodified sulfur concrete can be brittle and prone to cracking under certain conditions [3]. The introduction of modifiers can significantly improve the physical properties of concrete, allowing it to be used in a variety of construction areas, including infrastructure projects, industrial applications, and even extreme environments such as marine or space construction. The idea of using sulfur as a binder has been around for centuries. was, but its development began only in the 20th century. Early research into sulfur as a building material stems from the abundance of sulfur as a byproduct in the oil and natural gas industry. In the mid-20th century, researchers began experimenting with sulfur as a binder, which realized its ability to rapidly harden without water, which was a significant advantage over conventional water-based concrete [4].

Currently, one of the most important tasks of construction is the creation of new construction materials that can be produced using locally produced raw materials, as well as various types of waste. As for oil and gas production, the main types of waste are oil sludge and sulfur. Sulfur is not only a problematic environmental element, but also a resource component required in various fields of industry, agriculture, medicine and construction. In the construction industry, the use of technical sulfur as a binder in the production of a new type of concrete, that is, concrete without portland cement, has a special place [5-6].

Certain scientific and practical results have been achieved in our republic on the creation of modified sulfur concrete on the basis of modified sulfur binders based on industrial waste, secondary products of the gas and oil processing industry [7-9].

Nowadays, the goal of the construction industry around the world is to improve existing working technologies and introduce new technologies, which are resistant to physical and mechanical effects and chemically aggressive environments and have high efficiency in the long term, are environmentally safe and economically efficient. aimed at the production of building materials. Sulfur building materials belong to the type of composite materials of a special appearance, and sulfur or wastes of sulfur compounds are used as a binder in its preparation [10-12]. All known materials can be used as fillers and binders in the process of preparing cement and concrete mixes. Sulfur building materials include binders, fillers and modifiers [13-15]. In sulfur materials, technical sulfur or sulfur-containing industrial waste is used as a binder. Small amounts of suitable natural and artificial materials are used as fillers. Elemental sulfur has a molecular crystal structure, its crystals form a closed molecule, and sulfur atoms in this crystal molecular structure are connected by strong covalent bonds [16-22].

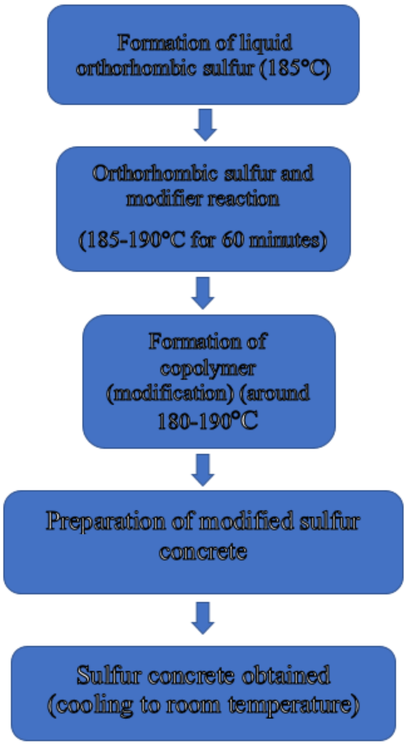
Nowadays, the demand for construction materials in places where there are manufacturing industries, especially in areas with saline soils, demands that the used building materials have high resistance to various aggressive environments, including corrosion. Standard service life of construction materials for construction buildings is 50-60 years. However, the service life of today's building materials is broken in 1-2 years after the facility is put into use, and repair work is carried out again in 6-8 years. Nowadays, if the service life of many newly constructed buildings is 60 years, by extending its service life for another 4-5 years, it is possible to save 3% of the total capital investment in one year. For this, it is necessary that the composition, structure, hardness and other parameters of the construction materials used in the construction of the building comply with the regulatory documents. Also, one of the important factors is to increase the corrosion resistance of construction materials of buildings under construction in all places. Buildings being built in especially saline areas should meet the same requirements [23-28]. One of the advantages of sulfur concrete is its resistance to acidic and salty conditions. The properties of sulfur materials often depend on the components included in its composition. Each component affects the rheological, physical-mechanical and operational properties of concrete mixtures. Therefore, the effect of each component should be studied not only at the stage of its preparation, but also during the design of the material. Various modifiers are used to control the properties of sulfur materials. The use of modifying additives in the preparation of sulfur materials is one of the most rational ways of managing their production technology. Various organic and inorganic compounds are used as modifying additives [29-30]. Using modified sulfur binders, sulfur concrete exhibits excellent resistance to high acid or salt concentrations. During the chemical modification of sulfur concrete, the structure of sulfur concrete forms a small crystal structure due to the occurrence of a newly modified sulfur-polymerization reaction. Polymerized sulfur exhibits a very strong corrosion resistance compared to crystalline sulfur. [31-35].

Using organic compounds as modifiers, we found it appropriate to obtain sulfur concretes and obtain building materials with a new composition by testing its properties in practice. Corrosion resistance of sulfur concrete samples made by using silico-PB, PEM compounds from organic compounds as modifiers in aggressive environments, including: in 10% H2SO4, HCl, HNO_3, H_3PO_4 acid solutions, in 3% Na_2SO_4, NaCl, NaF solutions , 10% NaOH, pH=4-10 and was studied in motor oil, dichloroethane and diesel fuels.

Research methods. Samples of sulfur concrete produced by us in laboratory conditions based on various modifiers (the composition of the samples are in Table 1) were presented and tested for their stability in corrosive environments. Sulfur concrete samples taken for research were taken in 5x5x5 size (Sample I silico-PB, , Sample II PEM,) in 10% H_2SO_4, HCl, HNO_3, H_3PO_4 solutions, 3% Na_2SO_4, NaCl, NaF corrosion resistance was studied in salt solutions, 10% NaOH, pH=4-10 and in aggressive environments selected as organic substances: machine oil, dichloroethane and diesel fuels. The coefficient of stability of the samples to corrosion in aggressive environments was determined by the reweighing (gravimetric) method after the initial samples were tested in various aggressive conditions for a certain period (54 days).

Table 1. Sulfur concrete composition.

Additives	sulfur	Sand	white saja	Organic modifier	all
Massa %	28	56	14	2	100



Results and discussion. Corrosion stability of modified sulfur concrete samples was determined by changes in mass, appearance and strength of concrete samples. The coefficient of chemical stability (Kb.k) was determined by the change in compressive strength after processing in aggressive environments. The obtained results are presented in the table below.

Corrosion of sulfur concrete in aggressive environments chemical stability

Aggressive environment	Stability coefficient (54 days)	
	Sample I	Sample II
10% acid:		
- sulfate	0,33-0,51	0,30-0,48
- chloride	0,52-0,61	0,51-0,60
- nitrate	0,53-0,62	0,52-0,61
- phosphate	0,71-0,75	0,70-0,77
3% salt:		
- sulfates	0,71-0,81	0,70-0,80
-x lorides	0,71-0,81	0,70-0,80
- fluorides	0,90-0,95	0,89-0,96
10%- NaOH	0,51	0,48
Medium pH = 4-10	0,67-0,72	0,69-0,73
Organic matter:		
- car oil	0,66-0,90	0,68-0,92
- dichloroethane	0,71	0,60
- diesel fuel	0,85	0,67

It can be seen from the data in the table that the stability coefficient of sample I in the three studied acid environments is in the range of 0.33-0.77, while the stability coefficient of sample II in acidic environment is equal to 0.30-0.75. From the indicators of the stability coefficient of the samples in this acidic environment, we can see that the corrosion stability of sulfur concrete in the acidic environment is lower in sulfuric acid, and slightly higher in phosphoric acid than in other environments. The main reason why the stability coefficient in the sulfuric acid environment is lower than the indicators in other environments can be explained by the fact that sulfuric acid belongs to the type of strong mineral acid and the solubility coefficient of elemental sulfur in sulfuric acid is higher than in other acids.

When the corrosion stability coefficient of these samples was studied in 10% sodium sulfate, sodium chloride and sodium phosphate solutions, the stability coefficient of sample I was in the range of 0.71-0.95, while the stability coefficient of sample II in salt solution was 0.70 It is equal to -0.96.

When comparing the indicators of the samples according to the type of salts, the indicators of the solutions of sulfate and chloride salts do not differ much from each other. But the indicator in fluoridated salt solutions differs from them, that is, the coefficient of corrosion stability of the samples in fluoridated salt solutions is slightly higher. This can be explained by the differences in the bond radii of the salts taken for the study. Here, it can be explained by the fact that the length of bond radii between metal-halogen atoms of fluorine salts is much smaller than the bond lengths between above metal-chlorine atoms and metal-oxygen atoms.

The coefficients of corrosion stability in 10% NaOH solution of all studied samples were found to be in the range of 0.48-0.53. Here, the lowest indicator was in sample I, while the highest indicator was seen in sample II (0.53). The fact that the coefficient of corrosion stability of two samples under the same conditions is different can be explained by the structure of the molecules of the samples. The slight advantage of the index of sample II in the studied environment can be explained by the presence of unsaturated polyethers in the molecule, its solubility coefficient and the difference in the temperature of liquefaction.

When samples were tested in the range of pH = 4-10, it was found that the stability coefficient of sample I was in the range of 0.67-0.72, while the stability coefficient of sample II was equal to 0.69-0.73. As this pH = 4-10 environment changes from acidic to alkaline, it can be observed that the coefficient of stability does not change much for all samples.

Corrosion stability coefficient of modified sulfur concrete was tested in the presence of organic compounds: motor oil, dichloroethane and diesel fuel. . It was found that the corrosion stability of these samples in dichloroethane is in the range of 0.50-0.73, while the coefficient of corrosion stability in diesel fuel is in the range of 0.77-0.87. The lowest indicator of the index in the environment of organic compounds corresponded to the environment of dichloroethane. The low values in this environment can be explained by the fact that dichloroethane is among the best organic solvents, and the samples are all polar molecules, so they are slightly soluble in this polar solvent.

Summary. According to the results of the study, modified sulfur and modifiers: sulfur concrete obtained on the basis of silico-PB, PEMs in 10% H_2SO_4, HCl, HNO_3, H_3PO_4 solutions, in 3% Na_2SO4, NaCl, NaF salt solutions are resistant to aggressive environments of sulfuric acid. It was found that 10% and 10% solutions of sodium hydroxide gave a slightly lower result than in other aggressive environments. The main reason for this is that partially unmodified elemental sulfur in sulfur concrete dissolves in sulfuric acid solution and alkali solution, so its stability against aggressive environments is lower than that of other aggressive environments. was 0.

Sulfur-silico-PB, modified sulfur concrete with PEM modifiers showed strong stability in various aggressive solutions. In summary, the silico-PB, PEM modifiers for obtaining sulfur concrete in this study gave superior results as modifiers.

References

1.J. Acordi, A. Luza, D.C.N. Fabrice, F. Raupp-Pereira, A. De Noni Jr, O.R.

K. Montedo, New waste-based supplementary cementitious materials: mortars and concrete formulations, Constr. Build. Mater. Vol. 240 (2020), 117877-117877.

2. M.J. Al-Ani, J. Abdalameer, Durability Investigation of Sulfur and Traditional Concrete within Aggressive Environments, Iraqi J. Ind. Res. 8 (3) (2021) 7–16.

3.M. Amran, et al., Properties and performance of polypropylene fibered high-strength concrete with an improved composite binders, Case Stud. Construction Mater. 17 (2022) e01621-e01621.

4.R. Bai, J. Zhang, C. Yan, S. Liu, X. Wang, Z. Jiang, Waste rubber-modified sulfur-fly ash-sand composites as low CO2-emission cements, Mater. Chem. Phys. (2023), 128060-128060.

5. N. Amanova, KhTuraev, M. Shadhar, U. Tadzhikhodjayeva, Z. Jumaeva. Sulfur-based concrete: Modifications, advancements, and future prospects https://doi.org/10.1016/j.conbuildmat.2024.136765

6. El Gamal M., El-Savi K., Mohamed A.-MO Complex mixer for the production of concrete. Case Stud Constr Mater. 2021, 14: e00495.

7. El Gamal M.M., El-Dieb A.S., Mohamed A.-MO, El Sawy K.M. Characteristics of modified silver concrete subjected to real sewerage environment with variable temperature, humidity and gas. J Build English. 2017, 11:1-8.

8. Erofeev V., Yausheva L., Bulgakov A., Bobryshev A., Shafigullin L., Afonin V. Khimicheskaya stoykost serobetona // Dostizheniya AIP. 2023, 13(6): p. 060021.

9. Erofeev, V. Yusupova, A. Bobryshev, A. V kn. Activation series of opal-cristobalite-tridimitovoy phase and technology of serobetone, IOP Conf Ser Mater Sci Eng 2018, 342: 042033.

10. Gasemi S. Nikudel, M. R. Zaluli, A. Khamekhchiyan M., Alizade A., Yusefvand F., Rais Gasemi A. M. Evaluation of the durability of aerated concrete and portland

concrete in laboratory conditions and marine environment. J Mater Civil Eng 2022, 34(8): 04022167.

11. Gulzar M.A., Rahim A., Ali B., Khan A.H. Issledovanie potentiala pererabotki serobetona. J Build Eng 2021, 38: 102175.

12. Gumenyuk A., Khela R., Polyanskikh I., Gordina A., Yakovlev G. Dolgovechnost betona s iskusstvennoy thermoplasticheskoy dobavkoy sery, IOP Conf Ser Earth Environ Sci 2020, 522: 032012.

13. Nedelkin V.I., Zachernyuk B.A., Korneyeva L.A., Solovyeva YE.N. Electrophilic sulfidation in the synthesis of oligoarylene sulfides. Butlerov Communications. 2018. V.53. No. 1. pp. 148-152.

14. Ginzburg B.M., Tochilnikov D.G., Lyashkov A.I., Lavrentev V.K., Leksovskii A.M., Pozdnyakov A.O., Pozdnyakov O.F., Sukhanova T.E., and Shepelevskii A.A. Polypara-phenylene sulfide as material for water-lubricated sliding bearings // Friction and Wear. 2010. Vol. 31. No. 4 Pp. 394-402.

15. Berlin A.A. Polymer composite material: structure, properties, technology. [Polymer composite materials: structure, properties, technology] textbook; SPb.: Profession. 2009. 560 p

16. Ginzburg B.M., Tochilnikov D.G., Bakhareva V.YE., Anisimov A.V., Kireyenko O.F. Polymer material for bearings, skolzheniya, lubricant. [Polymeric materials for plain bearings lubricated by water]. Review // Journal of Applied Chemistry. 2006. V.79. No. 5. P.705-716

17. Yamamoto Y., and Takashima T. Friction and Wear of Water Lubricated PEEK and PPS Sliding Contacts // Wear. 2002. Vol. 253. No. 7-8. P.820-826.

18. Zachernyuk B.A., Savin E.D., Nedel'Kin V.I. Recent advances in the chemistry of sulfur-containing poly(arylenes) // Polymer Science. Series C. 2002. Vol. 44. No. 2. Pp. 168–184.

19. Korneyeva L.A., Nedelkin V.I., Zachernyuk B.A. Ecological aspects of obtaining polyarylene sulfides based on sulfur Scientific aspects modern research: Sat. stat. intl. n.-practice conf. Novosibirsk, 2017 C. 23-26.

20. Kolobova E.A., Lozhkina D.A. Waste Processing Oil and Capacity Radiationresistant Composites on their Basis. [Modern prob. automation and control In energy and engineering: Sat. scientific tr. intl. n.-practice]. conf. Penza. 2015. P.335-345

21. Akhmedova A.R., Serebrennikova O.V., Shiganova. Geochemical characteristics of oil central Sibirskoy platform. [Geochemical characteristics of the oils of the central Siberian platform] Neft Gas exposition. 2017. No. 7 (60). pp. 68-73

22. Agabekov V.YE., Kosyakov V.K. Oil and gas: technology and product processing. [Oil and gas: technologies and products of processing]. Minsk: Belarus. Science. 2011. 459 p.

23. Shvetsova A.V., Sediki D.B., Shinkar YE.V., Berberova N.T. Development process of electromediated synthesis of organic polysulfides and cycloalkanes, hydrogen peroxide and elemental series. [Development of the process of electromediator synthesis of organic polysulfides based on cycloalkanes, hydrogen sulfide and elemental sulfur]

Latest technologies for the development of hydrocarbon deposits and ensuring the safety of the ecosystems of the Caspian shelf: Proceedings of the VIII Intern. scientific and practical. conf. Astrakhan, 2017. P. 192-196.

24. Nedelkin V.I., Kudryashova I.N., Zachernyuk B.A., Solovyeva YE.N., Chernova N.S. The gas purifier is a new type of utility. [New approaches to the utilization of sulfur in gas cleaning] Modern problems of development of the textile and light industry: Sat. mat. intl. n.-tech. conf. M., 2012. P.30-31 p.

25. Amanova N.D., Turayev Kh.Kh., Beknazarov Kh.S. Properties of new modified polymer sulfur concrete // Actual problems of modern science and innovation in the Central Asian region: collection of articles of the international conference. -Jizzahk, -2020. - p. 71.

26. Amonova N.D., Turayev H.Kh., Beknazarov H.S., Eshkurbonov F.B. Issledovaniye kinetiki termokislitelnoy destruksii iskhodnogo i modifisirovannix obrazov seri metodami DTA i TGA [Study of the kinetics of thermal-oxidative destruction of the original and modified samples of a series by DTA and TGA] Science and World. International Scientific Journal, No. 6 (82), 2020, Volume 1.

27. Amanova N.D., Torayev Kh.Kh., Beknazarov Kh.S. Synthesis and research of new polymer concrete. [Synthesis and study of new polymeric sulfur concrete] Universum: technical sciences: scientific journal. Part 3.M., Ed. "MSHO"-2020.-No. 6 (75).- C.5-8.

28. Mohamed A. M. O, Gamal M. E. Sulfur concrete for the construction industry; a sustainable development approach. J. Ross Publishing, Inc., 5765 N. Andrews Way, Fort Lauderdale, FL 33309.

29. Khait Turaev, Dilnoza Shavkatova, Nodira Amanova, Mokhanad Khatem Shadhar, Elyor Berdymurodov, Bektenov Nesiphan and Akhmad Hosseini-Bandegarae. Application of Sulfur-2,4-dinitrophenylhydrazine as Modifier for Producing an Advantageous Concrete// Baghdad Science Journal 2023, 20(6 Suppl.):2414-2433

30. D. Shavkatova, Kh. Turaev, N. Amanova, Basant Lal, Kh. Beknazarov, E. Berdimurodov, A. Hosseini-Bandeg. Preparing a New Type of Concrete Based on Sulfur-melamine Modifier// Baghdad Science Journal, August, 0000P-ISSN: 2078-8665 - E-ISSN: 2411-7986 https://dx.doi.org/10.21123/bsj.2023.

31. Grugel R.N. Sulfur 'Concrete' for Lunar Applications - Environmental Considerations, NASA/TM - 2008–215250.

32. Grugel R.N., Toutanji H. Sulfur ``concrete'' for lunar applications — sublimation concerns, Adv. Space Res. 41 (2008) 103–112.

33. Cha S. W. K., Kim S., Park H. S. Manufacture of modified sulfur polymer binder and characteristics of sulfur concrete. Korea Concrete Institute. Nov 2011; 23-6: 40-42.

34. Yoon J.H., Ryu Y.S., Lee J.K. Sulfur concrete. Korea Concrete Institute. Sep 2003; 15-5: 46-51.

35. Benkowitz I. Effect of sulfur on some of the properties of asphalts / I. Benkowitz, E.S. Boe // Proceedings of the American So

CONTENTS

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY

GROWING, STORAGE, PROCESSING AND AGRICULTURAL PRODUCTS AND FOOD TECHNOLOGIES