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PREPARATION OF SULPHUR CONCRETE USING MODIFIED SULPHUR AND MELAMINE

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Abstract: In this article, it was found expedient to obtain sulfur concrete based on organic nitrogen-containing compounds. Melamine, hydrazine, 2,4-dinitrophenylhydrazine, and bitumen were used as modifiers. The corrosion resistance of the obtained samples of sulfur concrete was studied in aggressive environments, including: 10% solutions of acids H_2SO_4, HCl, HNO_3, H_3PO_4, 3% solutions of Na_2SO_4, 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: melamine, sulfur concrete, modification, copolymer, corrosion, acidic, alkaline, sand, plasticization, polymer, aggressive environment, spectrum, thermogravimetry, scanner, dispersion.

Introduction. Originally developed in the United States, sulfur-based concrete has undergone extensive research to improve and enhance its properties. Studies have consistently demonstrated the safety and reliability of sulfur-based concrete as a construction material. Sulfur, which is found in crude oil and gas products, is an economical choice over other base materials due to its low cost. In sulfur-based concrete, sulfur primarily acts as a binder. The composition also includes other components such as aggregates, sand, fly ash, and stabilizers. With its low porosity and high-density mix, sulfur -based concrete has higher strength than conventional cement concrete. The unique matrix stru cture of sulfur-based conc rete may be due to the combination of sulfur and aggregates.

In Poland, work is underway on the use of sulfur and its waste in the production of building materials. The results of the research are reflected in many articles and patents. Polish technologies for obtaining building materials based on modified sulfur differ from other technologies in their complexity and multi-stage nature. In the scientific works of researchers[5], a method for obtaining stable polymerized sulfur from elemental sulfur and unsaturated hydrocarbons was proposed. In this work, polymerized sulfur was added to the solution in an amount of 1–20% by mass of the raw material used at a temperature of 125°C-130°C with constant stirring. In subsequent stages, the temperature of the total mixture was gradually increased, but it was not recommended to raise it above 5°C within 30 minutes; the studies were carried out at temperatures in the range of 140-145°C[4]. The mixture was kept at this temperature for 3 hours. In the next stage, the temperature was gradually reduced to 130-135 °C at a rate not exceeding 5 °C for 30 minutes. The total time of temperature reduction was 3 hours. In the inventions of the following authors [7], various methods of sulfur modification are also proposed: in particular, the effect of various solvents, styrene, etc. on the polymerization process of sulfur is studied, and recommendations for their use are given. The patent [6] proposing the physical structure of modified sulfur has aroused great scientific interest among many researchers. According to the authors [6], modified sulfur is a eutectic mixture, a solid solution of sulfur and modifiers. As a modifier, a mixture of unsaturated hydrocarbons and styrene, in the form of dimers and trimers of cyclic compounds (dicyclopentadiene), in an amount of 2-7% by weight at a temperature of 135 °C was used. It is noted that sulfur does not chemically interact with modifiers. The purpose of the modification is to obtain stable anisotropic crystals of the α-rhombic form that do not undergo polymorphic transformations. The content of the β-monoclinic form does not exceed 0.1%.

This study proposes the use of ENB as a sulfur modifier for the first time. The use of ENB is explained by its stability and low toxicological properties compared to DSPD. Detailed information on the properties of the product is not available. The studies based on this invention, as well as most of the others, were carried out in vitro in laboratory conditions. There is no information about carrying out the process under conditions close to industrial scale. The lack of experimental results is considered a significant drawback of such work.

SHell [6] noted that when modifying sulfur with naphthenes or olefinic hydrocarbons, organic polysulfides are formed. Modified sulfur is the addition of polysulfides to elemental sulfur. The presence of organic polysulfides stabilizes allotropic forms of sulfur and prevents crystallization.

This fact was explained by the gradual (within 24 hours) transition of sulfur from the monoclinic form to the stable orthorhombic form, which is associated with a decrease in volume and contributes to the slow degradation of the material.

Methodology & empirical analysis. The stability of concrete under the influence of aggressive chemical and corrosive solutions is a crucial factor. This study investigated the stability of concrete based on the sulfur-2,4-dinitrophenylhydrazine modifier in various harsh environments, including 10% acid solutions (sulfuric, hydrochloric, nitric and phosphoric acids), 3% salt solutions (sulfates, chlorides and fluoride . salts), 10% NaOH, pH-changing environments (pH 4-10) and organic compounds (motor oil, dichloroethane and diesel fuel). EDS (Energy Dispersive Spectroscopy) analysis plays a crucial role in understanding the elemental composition of sulfur concrete. This advanced analytical technique provides important information about the distribution and concentration of elements present within the material. By using EDS analysis, researchers can gain valuable information about the performance and properties of sulfur concrete and optimize its properties for various applications. By evaluating EDS images and elemental maps, it is possible to confirm the presence of sulfur along with other elements, providing a broader understanding of the composition and performance of the material.

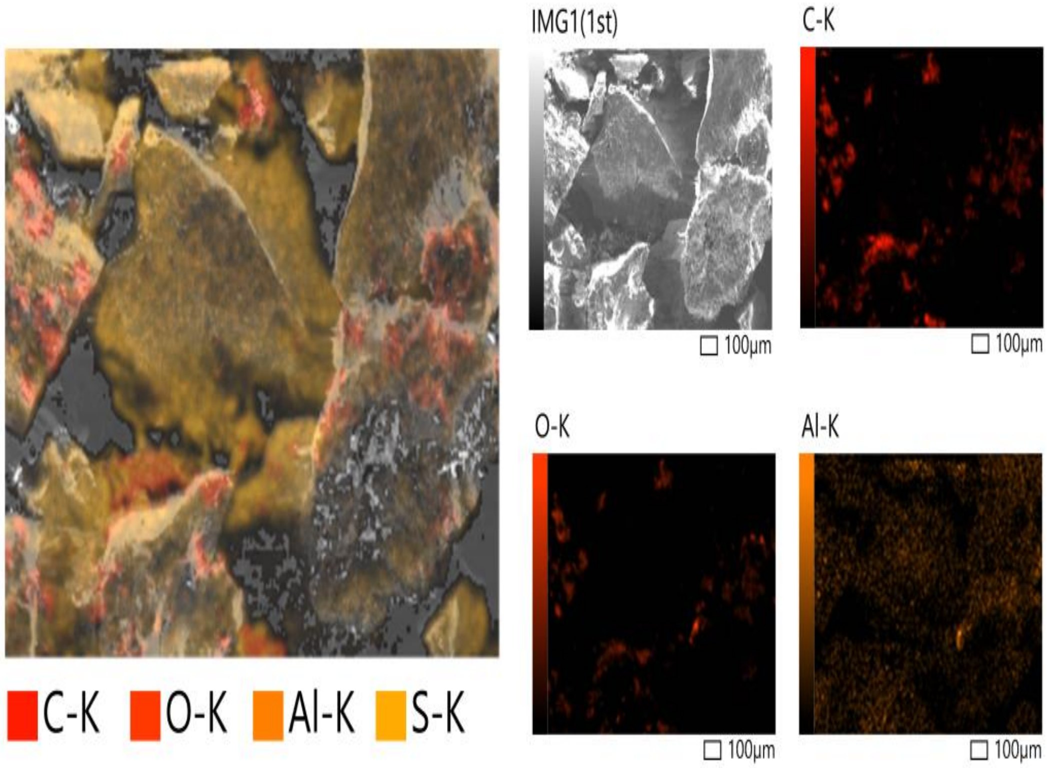

Figure 1. EDS images of the sulfur modifier 2,4-dinitrophenylhydrazine (a) and the corresponding EDS element map (b) are shown

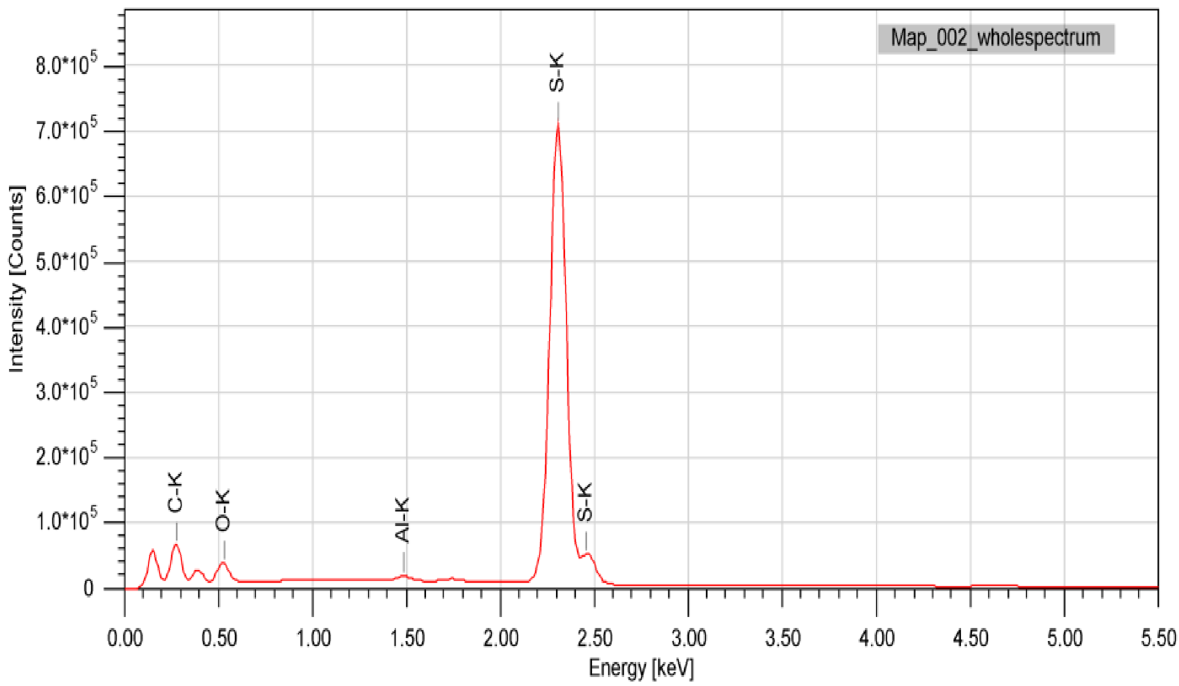

Figure 2. EDS analysis results of sulfur-2,4-dinitrophenylhydrazine, (a) elemental map and (b) EDS data

To determine the elemental composition of the selected modification material, a deep surface elemental analysis was performed on the sulfur-2,4-dinitrophenylhydrazine modifier. It was noted that the amount of sulfur was 33.91% of the total mass, confirming the presence of sulfur in the tested modifier. The analysis showed that oxygen atoms account for 9.2% of the total mass, and carbon for 56.63% of the total mass. These findings confirmed the presence of 2,4-dinitrophenylhydrazine in the sulfur-2,4-dinitrophenylhydrazine modifier. As a result, the EDS images and EDS element map results showed that the sulfur-2,4-dinitrophenylhydrazine modifier is composed of nitrogen, carbon, and sulfur elements, with sulfur serving as a linking component in the modifier.

Sulfur-modified concrete has proven to be an important tool for understanding the thermal stability and structural changes of 2,4-dinitrophenylhydrazine-modified concrete. This technique allows researchers and industry professionals to evaluate the effects of incorporating sulfur modifiers in concrete, which can lead to improved performance and longer service life of the material. Sulfur-modified concrete has received significant attention due to its improved properties, such as increased chemical resistance, increased strength, and reduced shrinkage time.

Table 1. Thermogravimetric results of the sulfur-2,4-dinitrophenylhydrazine modifier

ꞃo.	Temperature,	0 C Energy consumption values,	μ V Weight loss,	% Weight loss rate, mg/min
1	100	-0,00105	0,075	0,0155
2	200	-0,09585	0,84	0,6452
3	300	-0,856	43.206	0,688
4	400	-0,101	88.338	0,0538
5	500	-0,01322	91.855	0,018
6	600	-0,0125	93.022	0,0212
7	700	-0,0159	94.425	0,0258
8	800	-0,00725	96.114	0,0032
9	900	0,0109	96.312	0,00315
10	1000	0,00056	96.44	0,0031

II. Results. A method for obtaining polymer sulfur binders based on the modification of elemental sulfur, a waste product of the oil and gas industry, with nitrogen-containing organic compounds - melamine, 2,4-dinitrophenylhydrazine was proposed. It was found that 24 hours after pouring the modified sulfur concrete, its compressive strength increased from 80 to 95%. To produce concrete with high compressive and flexural strength, it is proposed to set the mass ratio of polymer sulfur concrete and filler materials to 1:2.

III. Conclusions. In this study, a new type of concrete using sulfur-2,4-dinitrophenylhydrazine modification was introduced and its various properties were examined. A new sulfur-2,4-dinitrophenylhydrazine modifier was developed and its structure was confirmed using IR spectroscopy and TG analysis. The surface structure of this modification was studied using SEM and EDS analyses. The innovative concrete was formulated with sulfur-2,4-dinitrophenylhydrazine modification and various components. The properties of this concrete were determined, leading to the following main conclusions:

(i) The results showed that the coefficient of thermal expansion for the sulfur-2,4-dinitrophenylhydrazine modified concrete was 14.8 × 10 -6 / 0 C.

(ii) The smaller aggregate sizes resulted in a denser concrete with a density of 2283 kg / m 3 . The density of the concrete gradually decreased with the increase in aggregate size. The average deformation of the tested concrete was 0.0026-0.0051, indicating higher deformation rates than conventional concretes.

(iii) The frost resistance coefficient of the sulfur-2,4-dinitrophenylhydrazine-modified concrete was approximately 1.0.

(iv) The water absorption on the surface of the sulfur-2,4-dinitrophenylhydrazine-modified concrete was up to 0.1-0.34%, and the water absorption coefficient of the concrete was 0.85, which increased the stability under water and high humidity conditions.

(v) The sulfur-2,4-dinitrophenylhydrazine-modified concrete showed excellent stability in various aggressive solutions.

In conclusion, the extensive studies in this study demonstrate the potential of sulfur-2,4-dinitrophenylhydrazine as a viable modifier for concrete.

References

1. Nedelkin V.I, Zachernyuk B.A., Korneyeva L.A., Solovyeva YE.N., Kudryashova I.N., Zachernyuk A.B. Elementnaya sulfur v polimeroobrazovanii. [Elemental sulfur in polymer formation] Structure and dynamics of molecular systems: proc. report XIX All-Russian. conf. Kazan 2012. p.72

2. Nedelkin V.I., Zachernyuk B.A., Korneyeva L.A., Solovyeva YE.N. Elementnaya sulfur as a monomer for the synthesis of polyarylenesulfides. [Elemental sulfur as a monomer for the synthesis of polyarylenesulfides]. XX Mendeleev Congress on General and Applied Chemistry: Proceedings. report in five volumes Ekaterinburg, 2016. V.2b. P.343.

3. 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.

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

5. Berlin A.A. Polymer composite materials: structure, properties, technology textbook; SPb.: Profession. 2009. 560 p

6. Ginzburg B.M., Tochilnikov D.G., Baxareva V.YE., Anisimov A.V., Kireyenko O.F. Polimerniye materiali dlya podshipnikov skoljeniya, smazivayemix vodoy. [Polymeric

materials for plain bearings lubricated bγ water]. Review // Journal of Applied Chemistrγ. 2006. V.79. Ռo. 5. P.705-716

7. Yamamoto Y., and Takashima T. Friction and Wear of Water Lubricated PEEK and PPS Sliding Contacts // Wear. 2002. Vol.253. Ռo.7-8. P.820-826.

8. Zachernγuk B.A., Savin E.D., Nedel'Kin V.I. Recent advances in the chemistrγ of sulfur-containing polγ(arγlenes) // Polymer Science. Series C. 2002. Vol.44. Ռo.2.Pp.168–184.

9. Korneγeva L.A., Nedelkin V.I., Zachernγuk B.A. (2017) Ecological aspects of obtaining polγarγlene sulfides based on sulfur [Ecological aspects of modern research: Sat. stat. intl. n.-pract. conf. Novosibirsk, pp. 23–26.

10. Kolobova E.A., Lozhkina D.A. (2015) Waste Processing Oil and Capacitγ Radiation-resistant Composites on their Basis. [Modern prob. automation and control In energγ and engineering: Sat. scientific tr. intl. n.-pract]. conf. Penza. P.335-345

11. Shavkatova D.Sh., Amanova Ռ.D., Turaev Kh.H., Bir va kўp componentsli nitrogen saklovchi organic modifierlar asosida oltingugurtli beton olish // Fan va technologγlar tarakkiγoti ilmiγ-tekhnikaviγ journal. Bukhoro, 2022, No. 4, 153-160-b. (02.00.00. Ռo. 14).

12. Shavkatova D.Sh., Amanova N.D., Turaev Kh.H., Modification of langan olingugurt va melamine asosida oltingugurtli beton olish // Karshi Davlat Universiteti Ilmiγ-Nazariγ, service magazine 2022 (5/1)55 .55-61-b.

13. Turaγev X.X., Shavkatova D.Sh., Amanova N.D., Raxmatova G. Studγ of the phγsical and mechanical properties of concrete based on modified sulfur and melamine. //Uzbekistan Milliγ Universiteti. 2023,[3/1/1] 503-505-b.

14. Amanova N.D., Shavkatova D.Sh., Khaγitova J.M., Turaev H. Kh., Beknazarov X.B., Makhmudova Yu.A. Stage of process of obtaining modified sulfur concrete based on local raw materials and studγ of radionuklides of sulfur concrete and Portland cement//. International Scientific Journal Theoretical & Applied Science 2022 at 03/08/2022γ p.107. 83-86-page.

15. G. S. Waldo, O. C. Mullins, J. E. Penner-Hahn, S. Cramer, Determination of the chemical environment of sulphur in petroleum asphaltenes bγ X-raγ absorption spectroscopγ, Fuel 71 (1) (1992) 53-57-b.

16. Modern superplasticizers for drγ building mixes: [Electronic, resource]: Information bulletin of the journal. Construction. Ռovosibirsk, 2006. Access mode: www. URL: http://www. тротуар. ru 14.10.2006. 1c

17. Guvalov A. A., Abbasova S. I., Kuznesova T. V. Efficiencγ of modifiers in regulating the properties of concrete mixtures // Construction materials. - 2017. - No. 7. – pp. 49-51 5.A.-M.O. Mohamed, M. El Gamal, Sulfur based hazardous waste solidification, Environ. Geol. 53 (1) (2007) 159-175-b.

18.E. Ռnabuife, Studγ of some variables affecting the properties of sulfur-inforced sugarcane residue-based boards, Indian J. Technol. 25 (8) (1987) 363-367-b.

19.B.K. Bordoloi, E.M. Pierce, Plastic sulfur stabilization bγ copolγmerization of sulfur with dicγclopentadiene, Adv. Chem. Ser. 165 (1978) 31-53-b.

20.S.-L. Lin, J.S. Lai, E.S. Chian, Modifications of sulfur polymer cement (MSB) stabilization and solidification (S/S) process, Waste Manag. 15 (5) (1995) 441-447-b.

21.M. Fuhrmann, D. Melamed, P. Kalb, J. Adams, L. Milian, Sulfur polymer solidification/stabilization of elemental mercury waste, Waste Manag. 22 (3) (2002) 327-333-b.

22.B. Currell, The importance of using additives in the development of new applications for sulfur, in: Symposium on New Users for Sulfur and Pyrites, Madrid, 1976, pp. 105-113-b.

23. J. Beaudoin, R.F. Feldman, Durability of porous systems impregnated with dicyclopentadiene-modified sulfur, Int. J. Cem. Compos. Lightweight Concr. 6 (1) (1984) 13-18-b.

24.W.L. Sheppard Jr., Sulfur mortars: a historical survey, Sulfur Inst. J. 11 (3–4) (1975) 15–17-b.

25. http://scientists.uz/uploads/journal/202311A.pdf

26. http://www.t-science.org/conf/2022/03-2022-1.pdf

27. https://bsj.uobaghdad.edu.iq/index.php/BSJ/onlinefirst/download/8858/4467

28. https://qarshidu.uz/source/Ilmiy%20jurnal/PDF/Aniq_fanlar_5-22.pdf

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