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Section 1. Materials Science

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OBTAINING CELLULOSE NANOCRYSTALS AND THEIR USE IN PAPER PRODUCTION

Abstract. Cellulose nanocrystals were obtained from waste paper by hydrolysis. The result of Fourier transform infrared spectroscopy (FTIR) for nanocellulose showed that no new chemical bonds were formed during the production of nanocellulose. The results of X-ray diffraction analysis showed that the crystallinity of the treated and untreated spots was 66% and 73.8%, respectively. The resulting nanocellulose particles were identified. improving the physical properties of paper sheets, in particular, tensile strength, stretch and tear performance. The maximum increase in mechanical properties was achieved with the addition of 6.0% nanocellulose.

Keywords: Paper, waste paper, composite material, cellulose, degree of polymerization, color intensity, tear strength, breaking length, rupture index, nanocellulose, nanocrystal.

Introduction. One of the problems of the paper industry today is the source of raw materials. From this point of view, the reduction of non-renewable resources has led to a trend towards more efficient use of waste paper generated in the paper industry as a raw material for various products. Waste paper as a biomass material Waste paper generated by the paper industry typically makes up about 7% of municipal solid waste and contains inexpensive cellulosic material. In industrialized countries, millions of tons of paper boxes are produced and used, resulting in a huge amount of waste paper. Due to the cellulose content of paper boxes, the production of valuable cellulose-based materials from them can become an alternative recycling method. With the advent of nanotechnology, more and more attention is paid to the extrac-

tion of nanocellulose from various renewable sources and its application in technical fields. The production of nanocellulose from waste paper today is of interest to researchers. For example, we have successfully recovered nanocellulose from waste paper by treating the waste paper with alkali and acid. Nanocellulose showed the following characteristics: diameter from 3 to 10 nm, length from 100 to 300 nm, crystallinity index 75.9%. A review of the literature showed that foreign scientists produce high-quality nanocellulose directly from old newspapers and recycled newsprint. Several studies have been published in recent years using nanocellulose as a reinforcing material for biocomposite materials; however, little is known about its use in paper and pulp production. There are several studies in which nanocellulose is made from old newspapers

or newsprint; therefore, deeper knowledge in this area is of interest. Nanocellulose has received considerable attention due to its use as an additive in papermaking to improve mechanical properties such as tear, tear and tensile strength. In addition, nanocellulose has several advantages: large surface area, biodegradability, high tensile strength and high. Thus, the addition of nanocellulose to paper pulp shows a high potential for increasing hydrogen bonds between cellulose fibers, resulting in stronger formed paper.

Results and discussion

Chemical composition analysis. The chemical composition of refined and unprocessed flax plant cellulose has been studied. Compared to untreated pulps, the content of extractives, lignin and pentosan in purified pulps decreased by 0.34%, 2.83% and 1.47%, respectively. The initial extractivity of crude pulp was about 0.85% and decreased to 0.55% after chemical pretreatment. This decrease may be caused by the removal of ink during ink cleaning. The lignin content decreased from 19.45% to 16.10% due to the decomposition of lignin during the bleaching stage. After bleaching, the chemical composition of the pulp has completely changed, indicating a highly effective removal of components such as lignin, extractives and hemicellulose in the alkaline and bleaching stages.

X-ray diffraction analysis.

The XRD spectra of raw and purified cellulose are presented in (Fig.1. on fig. 2) shows the diffraction peaks of dyed pulps at $2\theta = 16.10^\circ$ and 22.95° , which mostly correspond to untreated pulps. In addition to the main diffraction peaks at $2\theta = 16.10^\circ$ and 22.95° , the raw pulp showed two minor peaks at 12.55° and 29.85° , indicating that the presence of kaolin and calcium carbonate may be associated with the peak for kaolin it is usually at 12.35° and for CaCO_3 the most intense peak is usually at $2\theta = 29.85^\circ$. Refined pulp accounted for 66%, which is 7.8% lower than unprocessed pulp; During the reaction, it was found that the cellulose crystallization zone is destroyed by NaOH . The crystallinity index of nanocellulose was 70.25%. The nanocellulose crystallinity index was higher than that of purified cellulose, but lower than that of untreated cellulose, which is explained by the higher proportion of cellulose crystallites present in untreated cellulose. During hydrolysis, the amorphous region of cellulose was removed, which contributed to the low yield (35.55%) and high crystallinity of nanocellulose. Thus, nanocellulose had a high degree of crystallinity, and this property could be important for paper production.

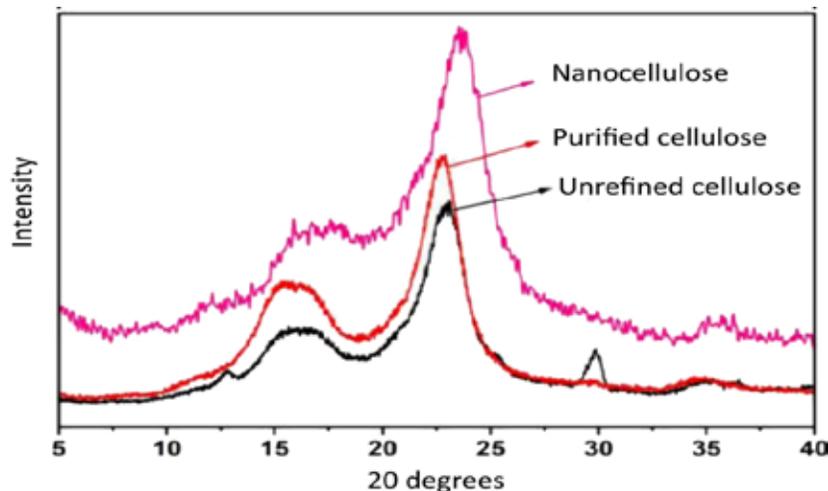


Figure 1. X-ray diffraction patterns of untreated (a) and purified (b) celluloses

Fourier transform infrared spectroscopy (FTIR) analysis. The infrared spectra of untreated

cellulose (a), purified cellulose (b), nanocellulose (c) and microcrystalline cellulose (d) are presented

in Figure 2. The absorption peak at 1165 cm^{-1} was consistent with the stretching of the glycosidic bond (C-O-C) of cellulose. The FTIR spectra in Figure 2 showed an extended vibrational absorption peak of -OH from about 3200 cm^{-1} to 3600 cm^{-1} , which was significantly stronger than that of the untreated celluloses (Figure 2 a). reported that the ink had an absorption band at 3380 cm^{-1} , which reduced the concentration of hydroxyl groups from untreated cellulose. In the spectrum of untreated (a) cellulose, the characteristic peak at 1733 cm^{-1} corresponds to the C = O stretching frequency of carboxyl groups in their acidic forms. In addition, the absorption peak at 1733 cm^{-1} can be attributed to the C = O stretching of hemicelluloses. The peak intensity at 1733 cm^{-1} of purified cellulose (spectrum b) was lower than that

of untreated cellulose C (spectrum a), which may be caused by the degradation of hemicelluloses by NaOH pretreatment. Figure 2 a (unrefined cellulose) showed the presence of lignin in areas at 1505 cm^{-1} due to aromatic vibrations in the C plane. The peak of cellulose at 1505 cm^{-1} (Figure 2 a) was significantly weaker than that of untreated celluloses (Figure 2 b), indicating the effectiveness of using chemical treatment to remove lignin. The 1263 cm^{-1} peak presented in the cellulose spectra was also a weak intensity attributed to lignin. Compared to the starting material, changes in the peaks at 1733 , 1505 and 1263 cm^{-1} indicated that the chemical treatment removed hemicellulose and lignin from the surface of the fibers. These results were consistent with the results of the chemical composition analysis.

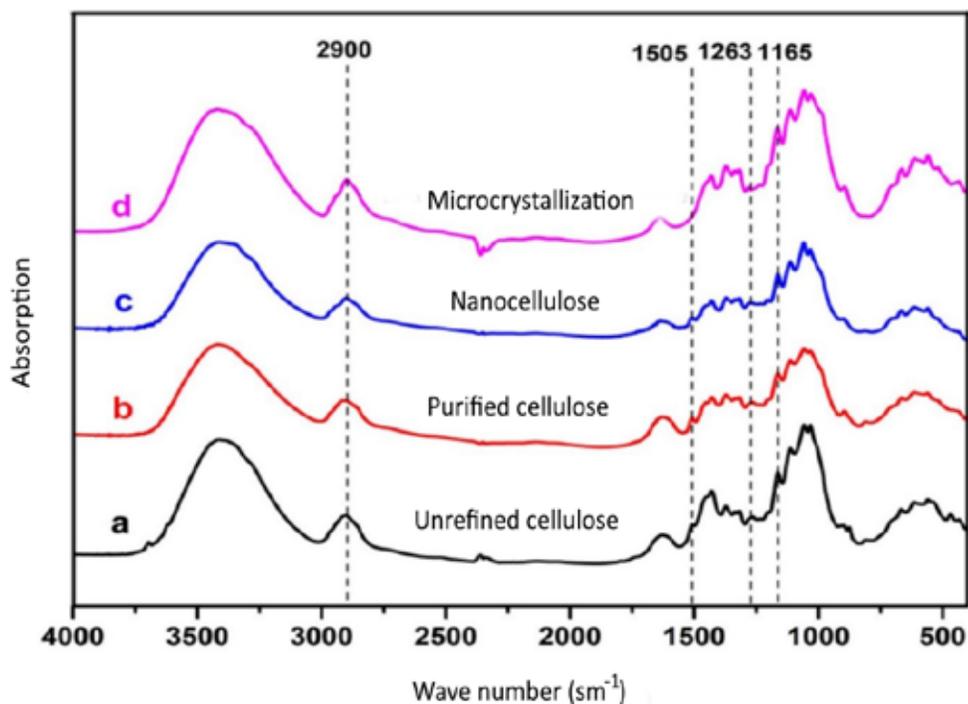


Figure 2. FTIR spectra of untreated cellulose (a), purified cellulose (b), nanocellulose (c), and microcrystalline cellulose (d)

The spectrum of nanocellulose includes areas similar to microcrystalline cellulose. The peak near 1635 cm^{-1} was due to adsorbed water. The characteristic bands of β -(1-4) glycosidic bonds at 896 cm^{-1} as well as the C-O-C stretching vibration of pyranose at 1165 cm^{-1} were also clearly shown in the spectra,

which were the main features. Accordingly, the intensity of the C-H stretching at 2900 cm^{-1} was lower for the treated celluloses than for the untreated celluloses, indicating that the distortion of the hydrogen-bonding structure and crystal shape occurred during the ink purification process. This result was consistent with

the (XRD) result. Overall, these results showed that the molecular structure of cellulose was not destroyed after pretreatment with H_2SO_4 and the nanocellulose still showed the basic chemical structure of cellulose.

Effect of nanocellulose on physical properties of paper. With an abundance of surface hydroxyl groups, large specific surface area, high aspect ratio, excellent mechanical properties, and high heat resistance, nanocellulose has demonstrated its potential as a reinforcement in papermaking and to increase

the strength of paper sheets. Nanocellulose and carboxymethylcellulose have been used in papermaking to improve the physical performance of paper sheets without structural damage to the fibers. In the current study, flax plant cellulose nanocellulose and carboxymethylcellulose were added to the pulp to make paper. In addition, the effects of additives with different dimensions were evaluated on the tensile strength, tear index, burst index and elongation of the paper sheets with the results shown in Figure 3.

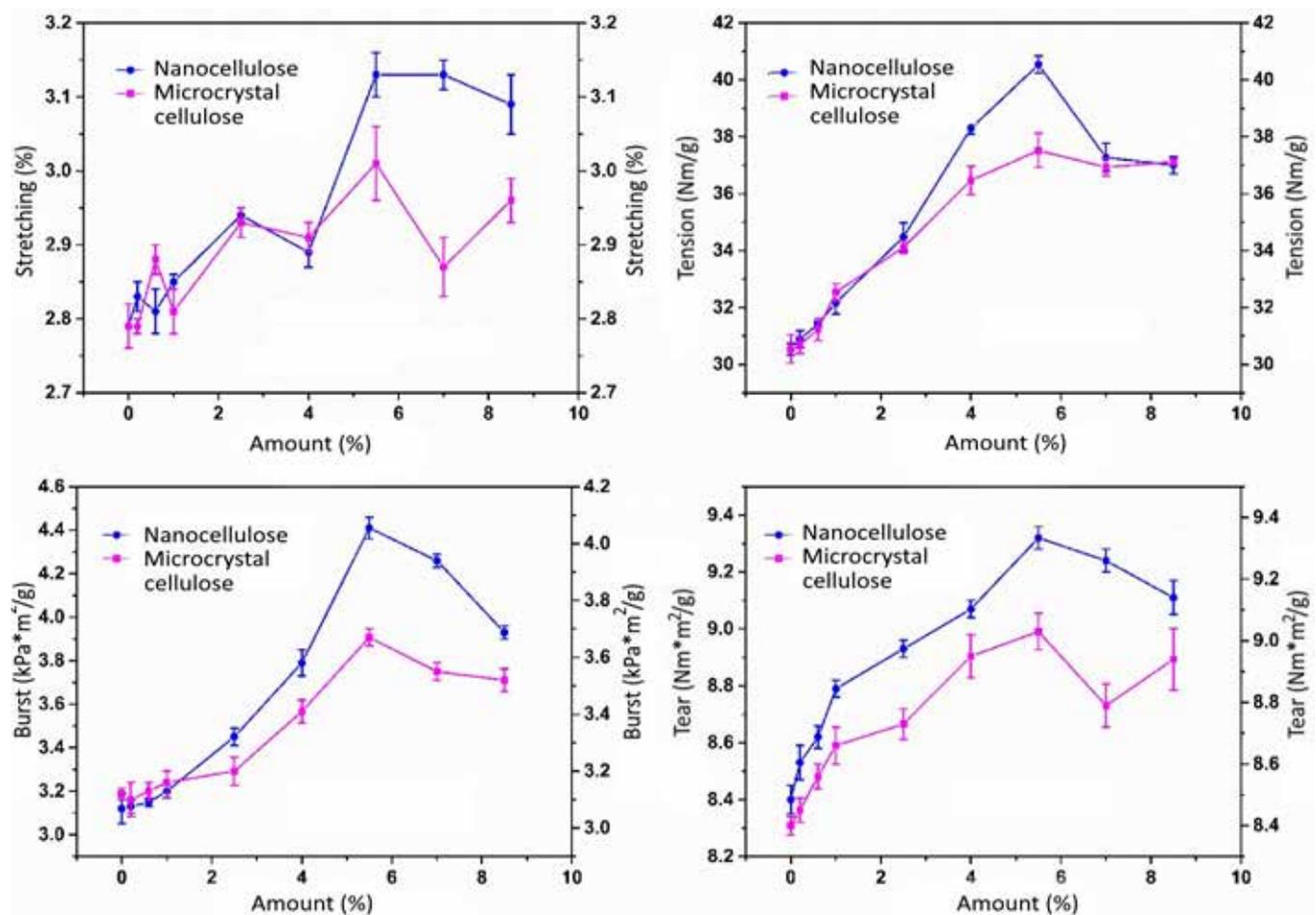


Figure 3. Effect of nanocellulose and carboxymethylcellulose content on elongation, burst and tear indices of paper sheets

The strength of paper sheets was increased by adding nanocellulose, which led to the formation of bonds between the fibers. In particular, the stretch index increased to a maximum of 5.5–6% nanocellulose, which was 32.75% higher than paper sheets without nanocellulose. The maximum values of the

tear index, tear index and elongation of paper sheets were obtained at a nanocellulose content of 5.5–6 wt. These measures were increased by 41.45%, 11.01% and 12.25% respectively. An increase in various physical properties has been achieved with the addition of nanocellulose, depending on the adhesion be-

tween the fibers. In addition, the physical properties of the paper sheets have been improved by the combination of hydrogen bonds. In addition, the relative binding area can be increased by the high specific surface area of nanocellulose to improve its physical properties. The maximum increase in physical properties is achieved by adding 5.5–6% nanocellulose. Despite this, with the addition of nanocellulose of more than 5.5–6%, the physical properties showed a tendency to decrease due to the aggregation of nanofibrous particles. The results lead to the conclusion that nanocellulose has demonstrated the ability to improve the physical properties of paper sheets.

This study also measured the effect of carboxymethyl cellulose as an additive in papermaking. On fig. 3 shows a comparison of the effect of different amounts of additives on physical properties. With the addition of 5.5–6% nanocellulose and 5.5–6% carboxymethylcellulose, the stretch index reached the maximum values of 40.55% and 37.55%, respectively. The gap index first increased and then decreased with increasing carboxymethyl cellulose content. This behavior can be explained by the increased peak pressure caused by the addition of the appropriate carboxymethyl cellulose before the paper breaks. However, adding more creates more negative charges in the system, which increases the electrostatic repulsion between carboxymethylcellulose and the fibers. Therefore, the explosibility index

of the paper sheet is lowered. The explosibility index was gradually increased to 17.65% with the addition of 5.5–6% carboxymethyl cellulose. With the addition of 5.5–6% carboxymethyl cellulose, the tear index and elongation increased by 12.85% and 7.95%, respectively.

This study clearly showed that physical properties were associated with nanocellulose and carboxymethylcellulose additives. The most obvious result of this study is that the highest tensile strength of paper sheets was obtained with the addition of nanocellulose and not with the addition of carboxymethylcellulose. For example, compared to carboxymethylcellulose, nanocellulose as an additive improved the physical properties of paper sheets. Thus, nanocellulose is a good candidate as an industrial reinforcing material to improve the physical properties of paper sheets.

Conclusion. The XRD patterns showed that the crystallinity index of the nanocellulose was higher than that of the purified cellulose, but lower than that of the untreated cellulose. FTIR spectra showed that hemicellulose and lignin were removed after chemical treatment. The thermal stability index of nanocellulose was lower than that of untreated cellulose. TEM has shown that nanocellulose has a length of 300 to 600 nm and a width of 10 to 30 nm. Nanocellulose has improved the physical properties of paper sheets. These physical properties reached their maximum values with the addition of 5.56% nanocellulose.

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EFFECT OF FLOCCULINANTS ON STABILITY OF PAPER MATERIALS

Abstract. A composite paper based on cellulose from Jerusalem artichoke and basalt fiber was obtained. The influence of new flocculants and fillers on the properties of paper was studied. The results obtained are shown in graph form.

Keywords: Cellulose, basalt fiber, strength, flocculants, composite paper, fiber hydration, filler.

Introduction. Currently, a number of works are being carried out to develop the chemical industry of the republic and replace existing technologies in its industries with new ones, as well as organize production based on them based on new technologies.

It should be noted that the need for paper and paper products in our country is extremely high. To eliminate this deficit, it was necessary to create innovative technologies for the production of paper and paper products, to speed up the production system several times.

The rapid development of technology leads to increased attention to the increasing requirements for the quality of products. Increasing the wear resistance of paper is one of the main indicators of quality.

It is knotems, i.e., the formation of agglomerates as a result of the combination of small particles with large ones. This serves to speed up the dewatering of the pulp and preserve its components.

Research objects and methods. Jerusalem artichoke cellulose, basalt fiber, a new type of flocculant PETF-1 and PETF-2, and stabilizers were taken as research objects.

Experience part. If the paper pulp is based on vegetable cellulose, basalt fiber, the reduction of β -potential in the components is only one of the ways to increase the preservation of the components, because hydration of fibers, fillers, formation of a network of fibers is the most serious factor of system stability. It is particularly important to mention the preservation of binder-aluminum polyhydrocomplexes, because the more binder that remains in the paper during the paper casting process, the greater the likelihood of creating a much stronger material. Sealing the connector leads to the fulfillment of the environmental requirement for groundwater.

In the developing technology of paper products based on vegetable cellulose and basalt fiber, when synthetic flocculants are used to preserve the binder, there is an opportunity to increase the durability of paper based on mineral fibers. For this purpose, special experiments were conducted, in which polyacrylamide (PAA) and polyethyleneimine (PEI), which are used in paper production, were used to increase the efficiency of aluminum polyhydrocomplexes.

Before us, a number of expert scientists conducted a number of experiments in this field and used synthetic polyelectrolytes and polyethyleneimine Polymin KM and Polymin R as flocculants [1].

Currently, polyethylene terephthalate (PET) filter bags are being rationally processed from polymer household waste and used for various fields (filter membranes, adsorption, paper industry). For this purpose, we took a two-proportional product (alkagoliz product) based on PET and used it as a flocculant in the paper industry. We tentatively named these products PETF-1 and PETF-2. These flocculants were used after comparison with commercially available flocculants.

The samples were prepared from 18% aluminum sulfate and Jerusalem artichoke cellulose and basalt fibers, while the pH value was changed from 4.5 to 9.0 during casting. PETF-1 and PETF-2 were used as flocculants, their consumption was from 0.25% to 2.5% by mass.

Results 1, 2 and 3 are shown in pictures. Fig. 1 shows the curves of the sample obtained without the addition of flocculants for control.

Analysis of the graphs allows us to identify certain patterns that are common to all tested flocculants and reinforcement additives. For all polyelectrolytes tested, the conditions under which the presence of aluminum compounds increases the strengthening effect can be selected. In addition, in the presence of polyelectrolytes, the dependence of aluminum polyhydrocomplexes on the values of the pN environment increases dramatically, and this dependence becomes more complex. In this case, it can be assumed that the β -potential will change under the influence of polyelectrolyte.

Moreover, it is necessary to take into account that the change in the value of rN affects not only the activity of polyhydrocomplexes, but also the shape of flocculants molecules, because the «coil-helix» type transition takes place. The system becomes more complicated, but within the framework of the tasks set before us, it is necessary to choose a recipe that ensures the achievement of the required level of composite quality, based on revealing the characteristics of the determining factors.

It was shown that the greatest efficiency was achieved when the native anionic polyacrylamide was used at 0.25 mass%. It should be noted that the maximum values in the tables of changes in strength from the value of rN correspond to the neutral zone. The control values of resistance of samples prepared without flocculants are, in most cases, lower than the values obtained using PAA. It should be noted that this is also typical of the case with polyethyleneimine.

When using polyethylenimine (Figures 1, 2), the maximum values are relatively abstract, and they are located from a low acid environment to a low alkaline environment. However, in all cases, there is a clear dependence of the durability of the samples on the rN values. This means that when synthetic flocculant is used for one or another purpose during the technological process in the investigated systems, the requirements for rN control during mass injection should be somewhat stricter.

Thus, the use of synthetic polyelectrolytes in the composition of paper-like materials based on mineral fibers is an effective way to increase its durability. The best results were achieved when polyethyleneimine was used: the strength of materials with 10–12 mass% aluminum polyhydrocomplexes in the composition increases 7 times in the presence of these polyelectrolytes (up to 3.0 and 2.0 MPa, respectively, when using PETF-1 and PETF-2). In this case, it should be noted that the strengthening effect is influenced not only by polymer, but by similarity to paper pulp, conditionally, with the presence of flocculant, more retention of aluminum hydroxides.

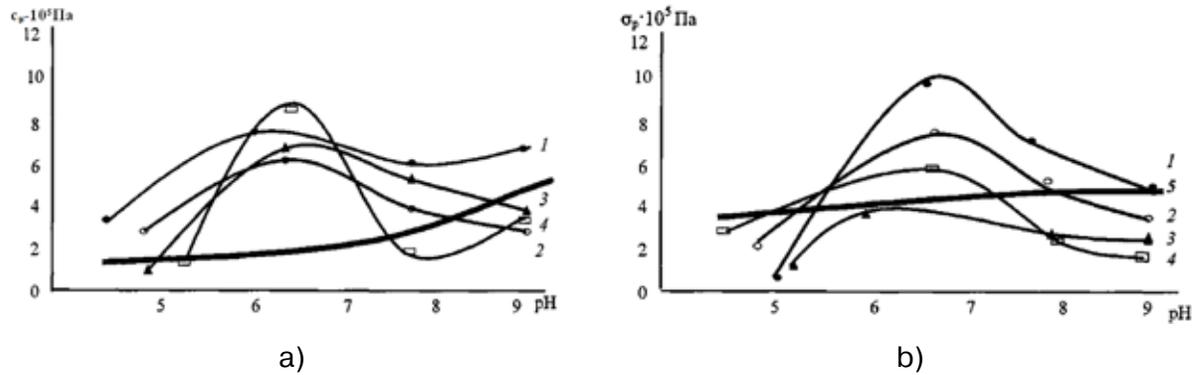


Figure 1. The effect of PAA on the strength of samples from Jerusalem artichoke cellulose and aluminum sulfate (a) and Jerusalem artichoke cellulose, basalt fiber and aluminum sulfate (b) at the consumption of flocculant (mass%): 1–0.25; 2–0.5; 3–1.0; 4–2.0; 5 – without flocculant

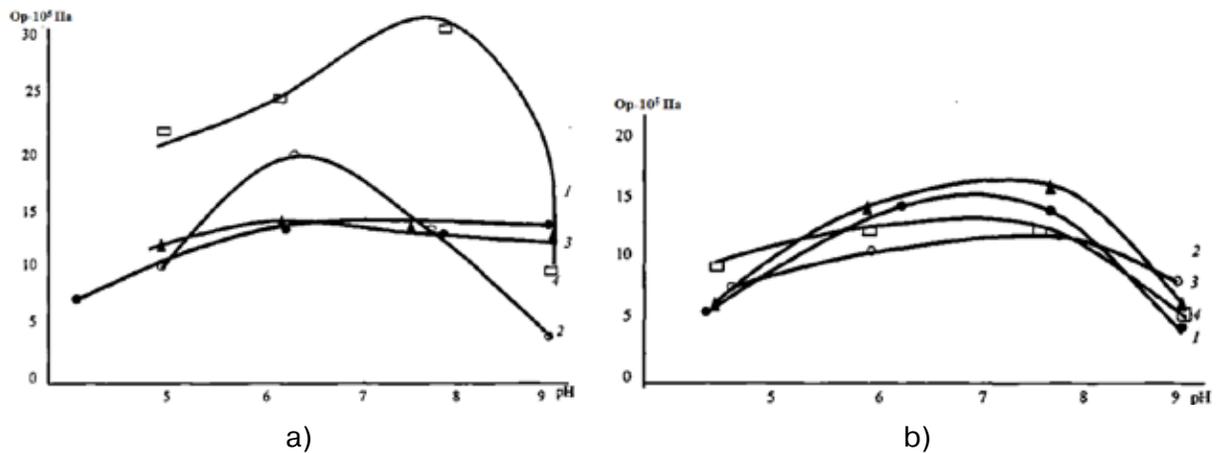


Figure 2. Effect of PETF-1 polyethylenimine on durability of samples from Jerusalem artichoke cellulose and aluminum sulfate (a) and Jerusalem artichoke cellulose, basalt fiber and aluminum sulfate (b) at consumption of flocculant (mass%): 1–0.25; 2–0.5; 3–1.5; 4–2.5

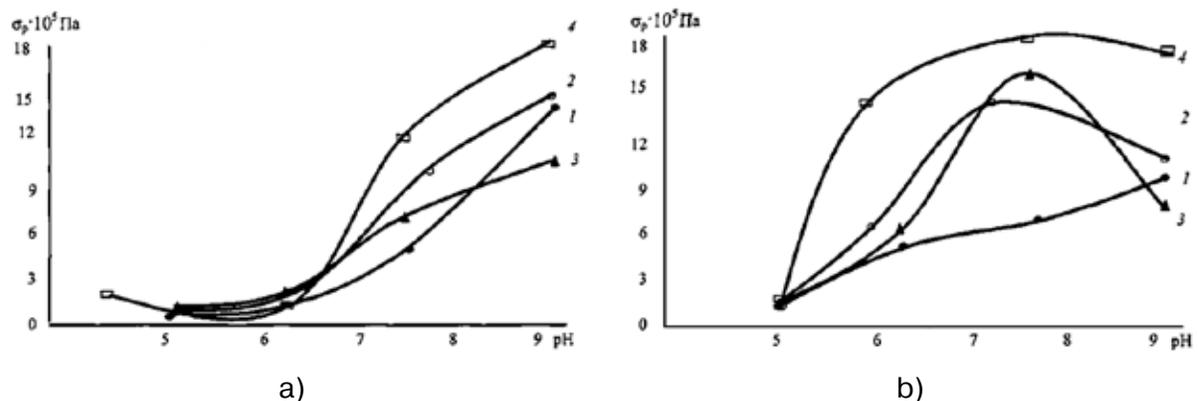


Figure 3. The effect of PETF-2 on the durability of samples from Jerusalem artichoke cellulose and aluminum sulfate (a) and Jerusalem artichoke cellulose, basalt fiber and aluminum sulfate (b) at the consumption of flocculant (mass%): 1–0.25; 2–0.5; 3–1.5; 4–2.5

True, in each individual case, it is necessary to carry out preliminary tests and technical-economic analysis to determine the optimal (optimal) condi-

tions for the use of binders and to initially select the most effective of the many means of increasing the preservation of paper pulp components.

Conclusion. In general, a technical solution was developed to ensure the reinforcement of composite materials with the help of polyhydroxocomplexes of metals based on mineral fibers, and in

order to ensure the necessary level of preservation of components during mass casting, it is envisaged to use appropriate flocculants in the preparation of pH medium.

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Section 2. Agricultural sciences

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AGROCHEMICAL PROPERTIES OF GYPSUM SOILS OF JIZZAKH DESERT

Abstract. In article indicated comparative results agrochemical and chemical characteristic basic virgin and irrigated soils. The research shown, that explored ground are characterized by miscellaneous by degree and type salinity, gypsum, small contents of organic material and main element of the feeding the plants. The reason this is disadvantageous soil-climatic particularities of the object, which promote the quick accumulation of saline spare in soils at the depth of 0.5–1.5 m (that is connected with low atmospheric moistening) that brings reduction a level of fertilities of the main soils of the under investigation territory.

Keywords: Saline soils, low salinity, medium salinity, agrochemical property, organic material, gypsum soils, hard-to-reclaim soils, gypsum content, sierozem-meadow, meadow solonchaks.

Introduction. Protection and protection of lands, restoration and reproduction of fertility of hard-to-reclaim land saline soils are the primary tasks of the modern farming system. In recent ears, in some regions, an intensive development of salinization and salt accumulation processes in soils has been observed, while agrochemical, chemical, agro physical, biological features and melioration and ecological state of soils are deteriorating [1; 3; 5; 7].

It known that the agrochemical indicators of the soil determine many of the most important features, such as the physical condition and fertility of the soil. In the process of soil development, one of its main properties is formed – fertility, which is closely related to the content of humus and nutrients. Analyzing the role of humus in soil formation, one cannot fail to recognize it as the most characteristic and essential part of the soil, with which, first, its fertility is associ-

ated. As the obtained data of the analysis showed, the described soils are not very rich in humus. The distribution of humus along the soil profile has a certain regularity. In all soil types, a greater amount of humus is contained in the upper horizons, and below the humus, content becomes very insignificant [4; 5; 8].

Objects and methods of research. The object of the study was the soils of the Jizzakh steppe (typical sierozems, sierozem-meadow, meadow solonchaks) of varying degrees of salinity and gypsum content.

Sample analyzes were indicated according to generally accepted methods of the analytical center of the State Research Institute of Soil Science and Agrochemistry.

Research results. The obtained results indicate that among the studied soils of the studied region, virgin typical sierozems, sierozem-meadow, meadow soils characterized by a higher content of humus than

irrigated light sierozems, sierozem-meadow, meadow-sierozem, and marsh-meadow and meadow soils. The content of humus in the upper horizons of all virgin soils studied different from 1.13 to 2.38% in the aisles, from 0.49 to 1.21% in the subsurface horizon, and naturally decreases with depth along the profile. The high moisture content of the soil, the proximity of mineralized groundwater (there used to be water here), high salinity and gypsum content apparently did not contribute to the active development of soil microorganisms and vegetation. With a decrease in the degree of groundwater, due to the conduct of drainage reclamation (conduction of a collector), virgin soils were subjected to drainage and used as pastures. In these soils, the amount of nitrogen is low throughout the profile – from 0.1 to 0.01%. The content of exchangeable potassium is also low throughout the profile of the gray earth soil. In meadow-serozem and sierozem-meadow soils, the content and profile distribution of mobile forms of phosphorus and potassium are similar to serozem soil, that is, low and very low, with the exception of the surface layer of 0–30 cm, where the content of mobile potassium is at the level of medium availability. In the meadow solonchak, there is little mobile phosphorus, and the content of mobile potassium in the upper part of the soil along the profile, with the exception of 0–17 cm, is quite high at the level of average supply (200–240 mg/kg).

Thus, these soils characterized by a low supply of mobile forms of phosphorus and potassium. Only in individual soil layers, the amount of mobile forms of phosphorus and potassium is contained in quantities at the degree of average supply. It can be said that there is no definite regularity in the content and distribution of these nutrients.

Since irrigated meadow-sierozem, sierozem-meadow, bog-meadow, meadow soils and light sierozems developed in the lower parts of the relief, they are more often composed of soils heavy in mechanical composition. They are not rich in humus, the maximum amount of humus here is concentrated in the

plow horizon 0.60–1.45% and in the subplow horizon, it sharply decreases to 0.56–0.97%, below which its amount gradually decreases, due to the small annual growth of organic matter due to high salinity.

Serozem-meadow soils considered semi-hydromorphic soils; in the soils of this subtype, residual features of sierozem soils and newly emerging features of meadow soils combined. Compared to virgin meadow soils, they are poorer in humus and nutrients. The humus horizon is shortened; deeper along the profile, the amount of humus decreases very sharply, which is associated with the complex structure of the mechanical composition of irrigated soils.

From numerous studies, it is known that for the normal growth and development of plants, optimal nutritional conditions are necessary, which are created by the composition, quantity and ratio of essential nutrients. At the same time, the change in the content of gross forms of soil nutrients is primarily associated with the content of humus. Based on the data obtained, due to the poverty of the studied soils in humus, the content of gross nitrogen in them is also low. According to our data, in all the studied soils, the greatest accumulation of them is noted in the uppermost horizons, and this indicator gradually decreases with the depth of the profile.

For example, in irrigated sierozem-meadow soils, the content of total nitrogen in the upper layer is 0.098–0.126%, in the subsurface layer its amount decreases to 0.076–0.087%, depending on the humus content and mechanical composition. Here, the phosphorus content is 0.743%, and in the middle of the profile, it naturally decreases to 0.593%.

Due to the high degree of salinity, the irrigated sierozem-meadow soil is characterized by the lowest content of humus and nutrients. Here, the humus content in the upper horizons is 0.56–0.60%, in the lower horizons it ranges from 0.25 to 0.39%, the amount of gross nitrogen, respectively, is 0.070%, and with depth its content decreases to 0.031–0.062%, which indicates a relatively weak soil enriched with humus and nitrogen. In irrigated meadow-serozem

soils, the humus content in the upper horizon is 0.80–1.21%; its minimum content was 0.22–0.31%. In these soils, the total nitrogen in the upper horizons, depending on the content of organic matter, ranges from 0.084 to 0.120%, decreasing down the profile to 0.028–0.042%.

In plant nutrition, along with nitrogen, a significant place occupied by the content of phosphorus. Characterized soils have a relatively high content of total phosphorus. As our studies have shown, total phosphorus in soils varies within a very wide range of 0.077–0.743%. Some of its fluctuations along the profile are associated with the mechanical composition of the rocks and the content of humus.

The upper horizons often contain more total phosphorus, which is associated with biological accumulation. In irrigated sierozem-meadow soils, the content of gross phosphorus in the upper horizon ranges from 0.176 to 0.743%, with depth this indicator decreases to 0.077–0.065%. In addition, in irrigated bog-mulberry soil, the content of gross phosphorus in the plow horizon is 0.243%, and in the lower horizons 0.142%, and, accordingly, in terms of humus content and mechanical composition, it changes along the soil profile. For example, in more humus horizons and heavy interlayers, its content reaches maximum values, and vice versa, in horizons with low humus and lighter in mechanical composition, it decreases to the minimum values.

The main source of plant nutrition with phosphorus is its mobile forms. Their quantity in the upper horizons of the studied irrigated soils ranges from 18.93 to 30.0 mg/kg; the least amount of mobile phosphorus is contained in irrigated bog-meadow soils and light gray soil. In the studied soils of the region, the content of gross potassium is 1.62–3.20%, the amount of mobile potassium is 127–380 mg/kg of soil.

In the studied soils, there is a certain dependence of the content of nutrients on the humus content and mechanical composition of the soil. The dependence of the content of nutrients on the mechanical composition of soils clearly expressed: there are more of

them in heavy loamy varieties than in light loamy and sandy varieties. In addition, with an increase in the degree of salinity, the content of humus and nutrients drops sharply to the minimum values.

From the data obtained, it found that the virgin soils of the study area more enriched in humus content, gross and mobile forms of nitrogen, phosphorus and potassium than irrigated soils. In general, the low supply of humus and nutrients to these soils can be explained by a smaller supply of root residues, the climate of this region, where high summer temperatures contribute to intensive evaporation of moisture from the soil. This, in turn, causes intense soil salinization and a high need for irrigation of plants, and contributes to the accumulation of a small amount of humus in the object under study.

The irrigated soils of the Jizzakh steppe characterized by such features as high gypsum content, as well as salinity and insufficient supply of humus and basic nutrients in horizons. According to the content of carbonates, the characterized virgin and irrigated soils do not differ from each other. The content of carbonates in all soils, depending on the mechanical composition of the soil profile, ranges from 2.86 to 10.30%.

In the studied soils, a variegation of gypsum content observed, as in the profile of soils, manifesting itself as an alternation of different degrees of gypsum content. When developing the degree of gypsum content, the depth of the gypsum horizon and the thickness of the gypsum horizon of soils, the content of gypsum in them taken into account. Depending on the content and distribution of salts along the profile, the following subdivisions of soils are distinguished. The studied soils do not have a definite regularity in terms of gypsum content. If in some soils, the content of gypsum is higher in the surface of the profile, then in others, it increases in the middle of the profile, and sometimes its addition observed in deep horizons. However, it should note that even such types of soils encountered that throughout the profile hold a high content of gypsum.

The content of gypsum in the composition of the studied soils, based on the classification of I. E. Pankova, divided into the following 4 categories [2]:

- *Soils with low gypsum content* (gypsum content is 2–10%), including virgin soils (5, 6 sections), the gypsum content in these lands in the plow horizon was 2.37–9.1%;
- *Soils with an average gypsum content* (10–20%), including virgin soils (sections 1, 2, 12), irrigated soils (sections 13, 14), the gypsum content in the plow horizon of these soils was 11.47–19.05%;
- *Soils with a high content of gypsum* (20–40%), including virgin soils (sections 3, 4, 7, 8, 9), the content of gypsum in the plow horizon of these soils was 26.04–37.62%;
- *Soils with a very high content of gypsum* (> 40%), including sierozem-meadow soils of the studied territories, can be attributed to this category and the maximum content of gypsum in these soils was 41.31–43.74%;

It should be noted that in the upper horizons of some studied irrigated soils (sections 15, 16, 17, 18) the gypsum content does not exceed 2%.

In the studied soils, the reaction of the soil is a very characteristic and sensitive sign of it; it reflects the most significant features of the chemical composition of the soil. The reaction of the soil – its acidity, neutrality or alkalinity – is of great importance for the chemical characterization of soils. The results of soil pH determination show that the reaction of the studied irrigated soils is mainly slightly alkaline, the pH value in

these soils ranges from 7.5–7.7, and in virgin soils, soil pH values are slightly lower compared to irrigated soils.

Conclusions. The given materials on the agrochemical properties of the studied soils show the difference in the quantitative content of humus and nutrients in the main types of soils of the Jizzakh steppe. Unfavorable soil and climatic features of the object, especially observed over the past 10–15 years, contribute to the rapid accumulation of salt reserves in soils at a depth of 0.5–1.5 m, which leads to a deterioration in the basic properties that identify soil fertility.

The upper 0–200 cm layer of most soils is medium to high gypsum. The horizon with a high content of gypsum falls mainly on the upper meter layer (15–40%) of the soil profile of virgin soils and they belong to the category of soils with a high and medium content of gypsum. In irrigated soils, a low content of gypsum observed.

The upper soddy horizon of the studied virgin soils is rich in humus, but is characterized by a low content of nitrogen, which is due to the high content of gypsum in the soils, salinity and long-term moisture to a high degree. In addition, these soils characterized by a low supply of mobile forms of phosphorus and potassium. In general, desertification of the territory and salinization of soils have a negative impact on the basic features of the studied soils and lead to a decrease in their fertility, while the agrochemical properties and nutrient regime of the soils deteriorate. A small amount of precipitation, high air temperature, low humidity, an abundance of winds and the resulting high.

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Section 3. Technical sciences in general

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ADSORPTION METHODS OF PURIFYING, DRYING AND PETROLING OF NATURAL GASES

Abstract. To date, the selection and use of various adsorbents for drying natural gas is one of the main problems of the gas transportation and processing industry. The degree of dryness of natural gas during transportation determines the degree of hydrate formation of natural gas in gas pipelines. This article presents the results of the degree of gas drying under dynamic conditions by various adsorbents.

Keywords: natural gas, adsorbent, dew point, gas hydrate, water, dynamic conditions, zeolite, silica gel, aluminum oxide.

The problems of drying natural gas with various adsorbents are considered in a number of publications, in particular, in [1–2].

The feasibility of using one or another method of adsorption drying and purification of natural gas depends on many factors and is determined by the plant capacity, gas composition, concentration of C_{5+} hydrocarbons, sulfur compounds and other impurities, consumer requirements for purified gas.

When solving specific practical problems related to gas purification and drying-topping, it is necessary to take into account the main advantages of a particular adsorbent, such as [3]:

- the ability to provide cleaning from all unwanted components in one system;
- ensuring deep gas drying;

- ease of operation and the possibility of automation.

The adsorption process for drying hydrocarbon gases is widely used at gas processing plants as the first stage of low-temperature technology, the final product of which is liquefied gases such as propane, butane, liquid nitrogen, and helium [4].

There is an opinion that the adsorption process of preparing gas for processing is metal-intensive and expensive compared, for example, with absorption, which is widely used in the fields.

However, a higher degree of moisture extraction from the gas and the absence of adsorbent vapors in the dried gas, which can condense in the piping and apparatus during gas cooling (not to mention entrainment), make this process reliable, stimulate

its improvement and widespread use in factory processing. gases.

As for the field preparation of gas for transportation through main gas pipelines, the main criterion for choosing a preparation method is the gas dew point for moisture and hydrocarbons, which excludes their condensation and precipitation in gas pipelines [1, 5].

The main adsorbents used for purification and drying-topping of natural gases in industry are [6]:

- active coals;
- zeolites;
- active aluminum oxide;
- silica gels.

On their basis, a number of technologies for cleaning, drying and topping natural gas have been developed and introduced into industry.

Activated carbons are porous industrial adsorbents, consisting mainly of carbon and having a number of features determined by the nature of their surface and porous structure [2]. The surface of carbon crystallites is electrically neutral, and adsorption on coals is mainly determined by the dispersion forces of interaction.

As a rule, the structure of coal is represented by a range of pores of all sizes, and the adsorption capacity and rate of adsorption of industrial gas components are determined by the content of micropores per unit mass or volume of granules.

Active carbon is the only hydrophobic type of industrial adsorbent, which determined its wide application for vapor recovery, purification of wet gases and waste water. However, at low amounts of the adsorbent (extraction of trace impurities from the gas stream), when the duration of purification is long, the humidity of the environment reduces the adsorption capacity of coal for the extracted component (absorption of carbon disulphide from ventilation emissions of viscose production).

Zeolites are widely used as adsorbents – aluminosilicates containing oxides of alkali and alkaline earth metals. Zeolites are distinguished by a strictly regular

structure of pores, which are filled with water molecules under normal temperature conditions [2–3].

Zeolites are both natural and synthetic. The industry produces five types of zeolites. The classification is based on a two-digit designation: first, the cation that is predominantly included in the zeolite lattice (K, Na, Ca), then the type of the zeolite crystal lattice (A, X or Y) is indicated.

Another type of inorganic adsorbents widely used in the oil and gas processing industry for drying gases is active alumina. The advantages of aluminum oxide (thermal stability, relative ease of preparation, as well as the availability of raw materials, etc.) make it possible to widely use it along with such adsorbents as silica gels and zeolites [7].

It is also widely used in adsorption processes (for drying gases, oils, cleaning gases and liquids from chlorine- and fluorine-containing compounds).

Silica gel is one of the most common mineral adsorbents in industrial technology, which has a large developed surface.

In appearance, it is a hard grain: transparent, opaque, colorless or light brown. Silica gel is produced in the form of balls, tablets or pieces of irregular shape with a grain size of 0.1–0.7 cm.

The chemical and adsorption properties of silica gels are affected by the presence of the =Si-OH group. OH groups mainly occupy the vertices of tetrahedra, which are exposed to the silica gel surface [2, 7]. As a result of chemical modification of its surface (introduction of amino-, sulfo- and nitrile groups, fluorine atoms, alkyl and alkenyl radicals into the composition of silica gel), it is possible to achieve a change in adsorption properties.

The main advantages of silica gels are [8]:

- low regeneration temperature (110–200 °C) and, as a result, lower energy consumption than in the regeneration of other adsorbents (active alumina, zeolites);
- the possibility of synthesizing silica gels in a wide range of specified structural characteristics using simple technological methods;

- low cost in large-capacity industrial production;
- high mechanical resistance to abrasion and crushing.

Adsorption gas treatment at the fields, in which there is no removal of liquid desiccants, contributes to environmentally friendly gas transportation through main gas pipelines.

As noted earlier, the prospects for using adsorption technologies to prepare natural gas for transport are increasing. In our country, there are production facilities for all the main types of industrial adsorbents, however, additional studies of their physical and technical properties are required in order to determine the most promising ones for their possible use in gas treatment plants for transport instead of imported ones.

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MODERN INDUSTRIAL ADSORBENTS FOR DRYING NATURAL GAS CLEANING

Abstract. As oil resources are depleted, natural gas is steadily moving to the forefront of the global economy. This article presents the results of the degree of gas drying under dynamic conditions by various adsorbents.

Keywords: natural gas, adsorbent, dew point, gas hydrate, water, dynamic conditions, zeolite, silica gel, aluminum oxide.

Along with the drying of gases by the absorption method, installations using the adsorption method are widely used in technology for drying various media [1].

Drying plants by the adsorption method have a number of advantages compared to the absorption method: they achieve a very low dew point – minus 70 °C and below; increasing the pressure in the system has little effect on the process; the equipment is not difficult to manufacture and there are practically no losses of chemicals.

Solid dryers – adsorbents – are preferred if it is necessary to remove other harmful chemical compounds from the gas, along with drying, since acetylene, aliphatic, aromatic and sulfur-containing hydrocarbons are simultaneously removed selectively [2].

To adsorbents used in the gas industry, there are certain requirements: large pore surface, high selectivity and rate of mass transfer, stability of adsorption properties during long-term operation, low resistance to gas flow, high mechanical strength.

In addition, adsorbents should be cheap, non-corrosive, non-toxic, chemically inert, and easily regenerated.

In each case, when choosing adsorbents, it is necessary to take into account also the cost of equipment, service life and prices of the adsorbent, goals process, etc. [3].

Adsorbents can be divided into the following general categories [4]:

- bauxite (natural minerals, consisting mainly of Al_2O_3);
- activated alumina (purified bauxite);
- gels (substances consisting of silicon oxide or aluminum gel and obtained through chemical reactions).
- molecular sieves (sodium-calcium silicates, or zeolites);
- carbon (charcoal), the adsorption properties of which are obtained as a result of activation. All these substances, except coal, are used for gas dehydration.

Activated charcoal is used to extract hydrocarbons from natural gas and gas purification from some impurities.

The activity of coal with respect to water is very low [1].

To clean natural gas from sulfur compounds from all range of industrial adsorbents currently in use, mainly synthetic zeolites, as other adsorbents (activated carbons, silica gels and alumogels) have a significantly lower adsorption capacity for sulfur compounds. This is explained non-selective co-adsorption of other components of natural gas. So, for example, the adsorption capacity of activated carbons for mercaptans decreases by 5–6 times during their adsorption from natural gas in comparison with their absorption from a gas stream that does not contain hydrocarbons, for example, nitrogen [4].

From modern industrial adsorbents – activated carbons, silica gels, alumogels, zeolites – the latter show the most high selective ability to absorb polar substances (H_2S , RSH, etc.) even when the temperature rises to 100 °C [5]. This property of zeolites is due to the presence of a strong electrostatic fields in the channels of their aluminosilicate crystals [6]. Under the action of this field, electron-donor atoms of polar substances are firmly are chemisorbed on the inner surface of zeolites, and sorption increases in the series $H_2O > R_2S > RSH > H_2S > COS > CO_2 > \text{hydrocarbons}$.

Synthetic zeolites also have the unique property comparability of the diameter of the entrance windows in the cavity of the zeolite with the size molecules of the extracted impurity, which allows for selective adsorption [7; 8].

The advantages of molecular sieves (zeolites) when used in industries are a decrease in the specific volume of the adsorbent, more low pressure drop across the adsorbent bed, elimination of gas losses due to adsorption of valuable components, long service life of molecular sieves, more reliable and stable operation of drying plants [8].

Molecular sieves containing a high proportion of silicon are usually used for drying sulphurous natural gases due to stability of these adsorbents to H_2S . In this case, two types of zeolites: A and X [1; 2]. The most common type A zeolite has mouths of pores of approximately the same effective diameter, equal to

0.4 nm. For type X zeolites, the effective diameter of the pore mouths lies in the range 0.9–1.0 nm. In the event that it is necessary to extract only water, it should be use type 3 A zeolite, since H_2S and CO_2 molecules cannot pass into adsorbent pores.

At natural gas desulfurization plants, the most widely synthetic zeolites NaA (4A), CaA (5A), NaX (13 A) are used.

The greatest influence on the capacity of zeolites for sulfur compounds render H_2O vapors. In the case of cleaning wet hydrocarbon gases H_2O sorbed in the frontal layers of the zeolite, almost completely displacing sulfur compounds. Significant effect on the capacity of zeolites sulfur compounds are also affected by the presence of heavy vapors in the gas hydrocarbons. The sorption capacity of hydrocarbons increases as increase in their molecular weight [4].

For the first time, molecular sieves (zeolites) were used in the world industrial practice for drying natural gas [1–5]. Molecular sieves also have the ability to remove some impurities from the water.

A valuable property of molecular sieves is the removal of water from natural gases enriched with acid gases (H_2S and CO_2).

At many foreign installations that prepare gas for pumping through pipelines, previously used as an adsorbent aluminum oxide or silica gel was replaced by molecular sieves in order to increasing the productivity of existing equipment and adsorbent service, reducing liquid hydrocarbon losses and lowering dry gas dew point [7].

Foreign scientific and technical literature describes a significant number of industrial installations for the purification of natural gases from sulfur compounds using synthetic adsorbents zeolites [4]. Such installations are widely used in the USA, France, Japan, Saudi Arabia [8]. Type used in installations desulfurization of zeolites depends on the nature of sulfur compounds. For purification from hydrogen sulfide and carbon sulfide, 4A zeolites and 5A (NaA and CaA), for purification from mercaptans –

zeolites 13A (NaX). Term service life of zeolites is 1000–2000 cycles.

The above review of scientific, technical and patent literature, dedicated to the purification of natural sulfur dioxide from impurities H_2S , thiols, vapors of

liquid hydrocarbons (C_{5+}) and moisture, showed that at present for this purification, mainly adsorption technology is used, consisting in the absorption of impurities by a layer of adsorbent, predominantly zeolite Na X.

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ON THE POSSIBILITY OF ASSESSING ENVIRONMENTAL RISKS FROM SOIL SALINIZATION IN UZBEKISTAN

Abstract. The problem of salinization and secondary salinization of soils in Uzbekistan on the example of Syrdarya province is considered in the article. The task of ecological risks assessment from primary and secondary salinization is put.

Keywords: salinization, ecological risk, assessment, identification, analysis.

Introduction

The problem of land salinization is widespread in Uzbekistan. One of the largest areas of irrigated agriculture in Uzbekistan is Golodnaya steppe – the sum of areas suitable for irrigation here is more than 800 thousand hectares. Natural salinity of Hungry Steppe soils before active development of irrigation was well enough studied by the mid-20th century. Hungry Steppe before irrigation was characterized by predominance of automorphous soils, which were referred to saline or potentially saline. In hydromorphic soils, the main natural process before irrigation was the process of modern salinization [1; 2].

Secondary salinization control was carried out with alfalfa and other crops at the beginning of XX century. However, the positive effect was not achieved.

In 1964 a government decree on improvement of meliorative condition of irrigated lands on the basis of drainage construction and leaching irrigation re-

gime with intensity 20–30% of net irrigation norm was adopted [2].

However, this approach has led to serious side effects: water withdrawal from rivers for irrigation has increased by 1.7–1.9 times. Drainage water discharge into rivers by the end of the twentieth century increased river water salinity, which also complicated the situation.

At present, the area of saline, irrigated soils in Hungry Steppe remains high and even increases. This is confirmed by the data on salinization of irrigated lands of Syr-Darya province obtained in the first half of the XXI century (Table 1).

It is possible to conclude from table data that significant part of saline soils passes from category of slightly saline soils to category of medium and strongly saline soils.

This state of affairs leads to a number of problems in different branches of national economy. Possible negative consequences from salinization can be as-

essed with the help of risk theory. Risks from soil salinization according to individual criteria have been evaluated by some authors [4; 5; 6], but a compre-

hensive consideration of risks from the problem of salinization, especially secondary soil salinization, has not been carried out so far.

Table 1. – Dynamics of salinization of irrigated lands in Syr-Darya province [3]

Year	Irrigated area, ha	Non-saline area, ha	Slightly saline, ha	Medium saline, ha	Strongly saline, ha
2012	286988	5050	232066	45790	4082
2013	286494	7675	224763	50011	4045
2014	286494	7059	223727	50222	5486
2015	287838	7073	230238	45955	4572
2016	287462	7305	222841	51765	5551
2020	286312	10333	202149	64091	9739
2021	287470	10058	204890	63542	8980

The aim of this article is an attempt to systematize the risks arising from secondary soil salinization, for the conditions of Syrdarya region of Uzbekistan.

Materials and methods

Syrdarya province of the Republic of Uzbekistan was chosen as the territory of the study, most of the territory of which is occupied by the so-called Hungry Steppe, the condition of which was considered above.

Elements of the risk theory were chosen as methods of research [7]. It is known that in carrying out any activity and making management decisions, risks inevitably arise. If there is no possibility to avoid risk completely, it is usually possible to reduce risk to acceptable values, including at water management impact on natural environment. At hydromeliorative impact economic and social risks can be considered as a consequence of environmental risk [8].

At present, there is no acceptable methodology for assessing the risk of reclamation activities. Works in the direction of creating such a methodology are carried out by a number of authors [7; 8].

The analysis of environmental risks is based on the following model [9]:

Block 1: Identification of environmental risks: identification of environmental risks for a given process.

Block 2: Environmental risk assessment: a) Qualitative and quantitative analysis of risk factors, b) Assessment of environmental and human hazards

Block 3: Environmental risk monitoring: monitoring environmental risks for a given process

Block 4: Environmental risk management: a) Choosing the risk management methods for a given process; b) Implementing environmental risk management measures; c) Monitoring the effectiveness of risk management; d) Adjusting risk management measures.

Results and discussion

Let's make an assessment of geo-ecological risks at various hydromeliorative works processes in the Hungry Steppe (by the example of Syr-Darya region). Consideration of risks will be made for existing method of irrigation with creation of hydromorphous regime

1. Identification of ecological risks

In this case the reason of ecologically unfavorable region is secondary salinization.

2. Qualitative and quantitative analysis of risk factors.

Let us consider the consequences caused by secondary salinization of soils (Fig. 1)

- a) Qualitative analysis
- b) quantitative analysis

1) Increased irrigation water consumption:

- In Kazakhstan and Central Asia, 50–60 million hectares of land suitable for irrigation. There are enough water resources for irrigation of 8–10 million hectares;

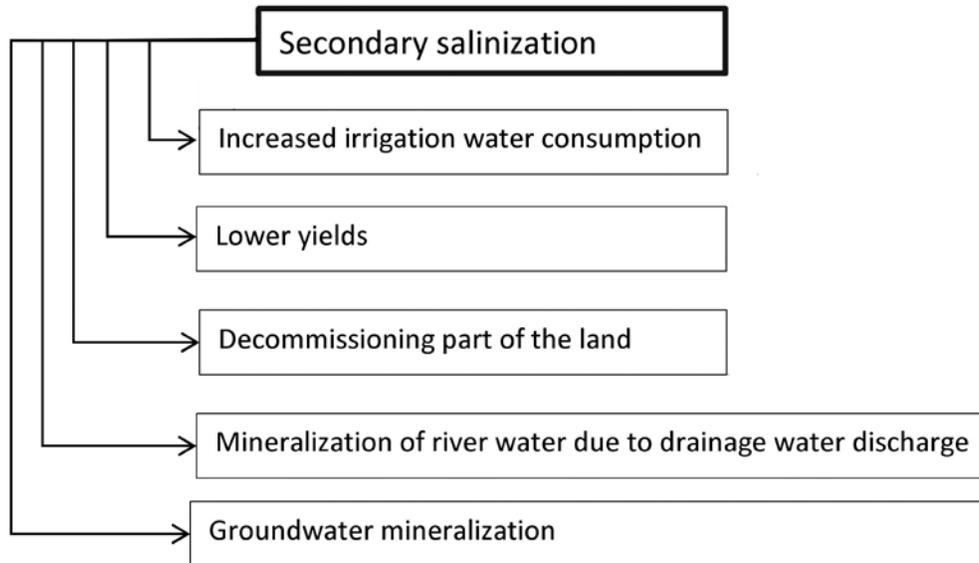


Figure 1. Risks of secondary salinization

- Irrigation norms of about 20 thousand m³/ha
 - 80% of irrigation water is spent on evaporation, and salts remain in the soil [10].
- 2) Yield reducing:
- with low salinity at 0 ... 33%
 - with an average salinity of 50%
 - with strong salinity at 67 ... 83%
 - with very strong salinity at 100% [10].
- 3) Decommissioning of part of the land
- The number of highly saline soils in the Syrdarya region;
 - 2020–9739 ha
 - 2021–980 ha [3, 11];
 - The area under raw cotton crops decreased from 2013 to 2016 in the Syrdarya region from 235185 ha to 191188 ha [3].
- 4) Mineralization of rivers:
- At the exit from the mountainous territory, the mineralization of river water does not exceed 0.3 ... 0.4‰ and has a bicarbonate character. As it mixes with return waters from irrigated territories and groundwater drained by rivers, the mineralization of river water reaches 1 ... 2 g/l, gradually acquiring a sulfate-chloride character due to the discharge of drainage effluents from the overlying irrigated territories. The mineralization of river waters has increased 3 ... 8 times over the past 50 years [10];
- Huge norms of fertilizers (up to 600 kg/ha) and pesticides after washing the soils strongly mineralize the waters and saturate them with toxic substances. These waters are discharged in large quantities into the Syr Darya and Amu Darya and are reused downstream for irrigation;
- 5) Mineralization of groundwater:
- Irrigation channels create sources of concentrated water loss in groundwater, thereby forming their local pressure;
 - Groundwater (with an unexplored degree of mineralization) can be used as an additional source of irrigation water [3].
- In 11 key areas of the Syrdarya and Jizzakh regions [12], the groundwater level at a depth of 0.8 ... 2.5 m, i.e. much higher than the “critical” level of the GW. Mineralization is weak (3.86 g/l), average 8–10 g/l, strong 10–25 g/l
- 3. Assessment of environmental hazards to the environment and humans**
- Irrigation water consumption – reduction of fresh water reserves – water crisis;

- Secondary anthropogenic salinization of irrigated lands is a process leading to disruption of the global biosphere mechanism [10].
- For humans (ecological and social risks):
- Decrease in yield – shortage of agricultural products [13];
- Decommissioning of part of the land is a social danger of unemployment of the population;
- Additional expenses incurred to minimize salinization, as well as to repair buildings and infrastructure elements affected by salinization.
- Layout;
- Flushing;
- Differentiated regime and technique of irrigation of agricultural crops [14];
- For difficult-to-reclaim gypsum-bearing soils, special complex agro-reclamation systems are required for large water consumption for washing >20 thousand m^3/ha for a period of improvement of 6–8 years.

4. Monitoring of environmental risks in this process

- Measurements of soil salinity;
- Measurement of the level of GW (measurement of the level of GW during the growing season, determination of the mineralization of GW);
- Control of GW effluents.

5. Environmental risk management

- The creation and maintenance of an optimal water-salt regime of the soil of the Hungry Steppe is achieved only with the implementation of a complex of reclamation measures, the most important of which are:
- Drainage;

Conclusion. The preliminary analysis shows that there are significant risks associated with soil salinization in the Syrdarya region.

The measures used require a long time and large capital investments. In addition, all these activities can also be sources of environmental and geoecological risks to be assessed.

Therefore, the tasks of further research are:

1. carrying out an updated assessment of the probability of occurrence of environmental and socio-economic risks from salinization;
2. determination of the extent of possible damage from secondary salinization to the environment and various spheres of human activity;
3. identification of risks and damage during the implementation of measures to reduce salinization (including the use of drip irrigation).

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EFFECT OF SALT CORROSION ON DECREASING CAPACITY OF ROAD BRIDGE SPAN ELEMENTS

Abstract. The article presents an assessment of the effect of salt corrosion of concrete and reinforcement on the bearing capacity of the superstructure elements. It is shown that the load-bearing capacity of superstructures subject to salt corrosion is almost 2 times less than the load-bearing capacity of superstructures without salt exposure.

Keywords: salt corrosion, span, bearing capacity, salt corrosion effect, reinforcement.

Introduction. Great importance in ensuring high corrosion resistance of reinforced concrete have a density, concrete structure and thickness of the protective layer. The less dense the concrete is and the thinner the layer of the armature, the faster corrosion process starts in more permeable place for moisture and oxygen. An increased permeability of the concrete can be compensated by increasing the thickness of the protective layer. In bridge structures must be provided with a protective layer of concrete with a minimum thickness of 30mm, checking (counting) in the light from the working surface. Reduction of the permeability of concrete is determined by the structure, i.e. the number, size and nature of the structure of the pores of the concrete. To withstand the specified granulometric composition of aggregates used division as coarse aggregate and sand fractions. This ensures a high degree of uniformity of concrete.

Main part. To protect reinforcement from corrosion greatly influenced by the curing mode of the structure. Excessively harsh conditions of curing and drying the concrete to suspend the normal process of hydration of cement, forming a structure with large porosity, which dramatically degrades the protective properties of the concrete. Intensive corrosion of reinforcement causes an additive in concrete chloride

salts (calcium or sodium) that is applied to acceleration of concrete hardening.

If there are cracks in the concrete at the steel reinforcement appears galvanic macropore: anodic areas of the reinforcement in the crack area; the cathode – is the place where the strength of adhesion to the concrete is not broken. Due to the small size of the anode sections compared to the small cathodes and the electrical resistance of moist concrete, the corrosive vapor is very intense. Corrosion of reinforcement at cracks this results in high speed [1].

The most common fracture that can occur during corrosion of reinforcement in concrete is the gradual reduction of the working section due to the transition of the outer layers of metal in the corrosion products. Due to the fact that the iron in the electrochemical process of corrosion can only be dissolved at the anodes of corrosion couples would be uneven reduction of cross section. But the character of corrosion damage can be different: from an almost uniform reduction of the cross section over the entire surface to pronounced ulcerative lesions [2].

Local ulcerative lesions of the valves present a much greater danger to reinforced concrete structures than uniform corrosion for two main reasons. First, in pitting corrosion, the local reduction of cross section the reinforcement is corroding much quicker than in

uniform. Secondly, the dangerous degree of damage of the structure can occur without visible external signs in the form of cracking and breaking off of the protective layer (which are usually observed at relatively uniform General corrosion), because of a small area of ulcerative lesions of corrosion products can exert a pressure sufficient to rupture the protective layer of concrete.

Different types of damage can be observed on the corroded surface at the same time. More often there is a gradual transition of one type to another: spot corrosion to general corrosion, with the development of deep local ulcers later on. Local corrosion, despite the lower weight loss of metal caused by it, is more dangerous than general corrosion, as it leads to a rapid loss of strength of individual sections. Despite the small weight loss of metal, especially sharply reduces the strength of intergranular corrosion, which breaks the bonds between the crystals.

It has been established [1; 2; 3] that defects in the form of reinforcement corrosion are the main focus of cracking.

Typical configurations of corroded reinforcement cross sections are given in (Fig. 1).

In the reinforcement of reinforced concrete spans the most common corrosion development according to the scheme "a".

The process of corrosion in reinforced concrete can occur according to two main schemes [4; 5]:

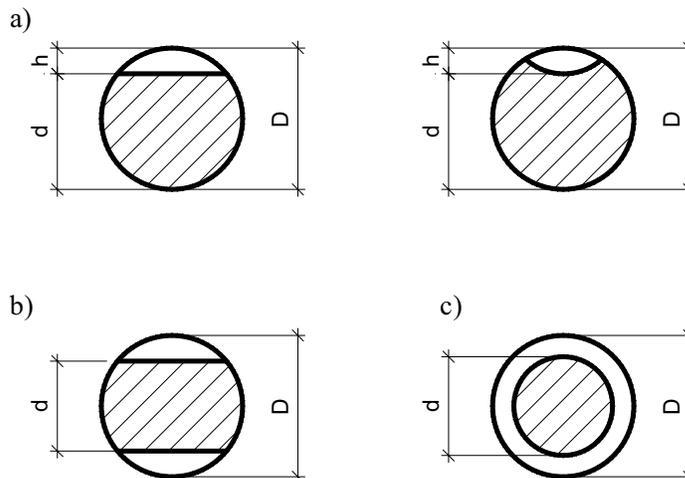


Figure 1. Characteristics of the configuration of corroded reinforcement cross sections. a) unilateral, b) bilateral, c) circular

1) corrosion of the reinforcement begins after the destruction of the concrete in the protective layer (corrosion of concrete), i.e., the cause of damage to the structure is the insufficient resistance of concrete;

2) development of corrosion begins with the reinforcement, when the concrete does not have sufficient protective properties, but it is not destroyed by the environment, which in this case is not aggressive with respect to it. The failure of concrete occurs under the pressure of rust that is growing on the reinforcement, i.e., it is partly mechanical in nature. This type of failure in concrete structures is generally caused by humid air or by periodic damping.

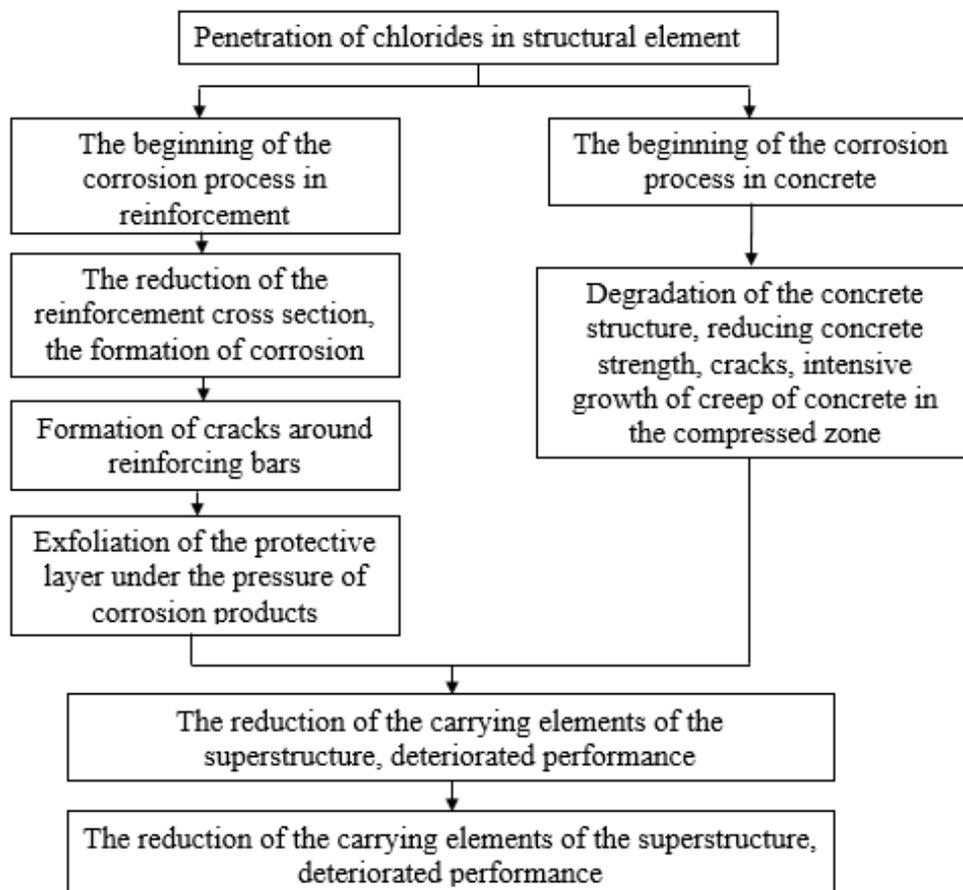
The formation of cracks in concrete is accompanied by its disengagement from tensile work in the zone of influence of the crack. In this zone, the stresses in the reinforcement are higher than in the neighboring areas where some of the tensile forces are taken up by the concrete. Macro-stresses can also occur in the crack area due to the difference in stresses. They increase the corrosion of the reinforcement. The deepest affection of the reinforcement is observed at the place where it intersects the crack. Less deep ulcers spread on both sides of the crack at a distance of no more than 5–10 mm. Further, as you move away from the crack, the corrosion fades sharply and appears in the form of plaque.

In Pic. 2 shows a diagram of the mechanism of action of chloride-containing environment to work reinforced concrete superstructures. As seen from Pic.2., ultimately, chloride-containing fluids result in reduced bearing capacity of the spans.

Numerous studies [3; 4; 6; 7] have shown that chloride-containing fluids have a significant influence on the mechanical properties of concrete.

In [6] presents the results of experiments when exposed to liquid chloride-containing environment on reinforced concrete in the compressed zone, in

the tensile zone and with the full impact. The test specimens range in age from 28 to 720 days showed that under these conditions there is a reduction of strength and modulus of elasticity of concrete up to 20–25%. Alternate saturation with liquid 1% solution and drying of the concrete intensively increases the drop of the mechanical properties of concrete [3; 4]. The decrease of strength in the loaded element is greater than at idle. The use of waterproofing additives improves resistance of concrete against the influence of chloride salts [8].



Picture 1. The mechanism of action chloride containing environment to work concrete superstructures

Existing ways to combat icing on bridges

Currently, the main means to combat ice on bridges is the use of salts [9].

In the climatic conditions of the Republic of Uzbekistan with sharp fluctuations of night and day temperatures there is an intensive thawing of ice on

the bridge after the use of de-icing reagents, and with the existing faults of waterproofing and expansion joints salt water quickly enters the body of concrete (photo 1). A sharp increase in ambient temperature contributes to intensive drying of concrete, and the amount of salt deposited in the body of concrete in

natural conditions of the Republic more than in temperate climatic conditions.

Despite repeated bans on the use of salts against ice, operating organizations continue to use various anti-icing salts, motivated by the lack of other methods of control.

Antifreeze and de-icing agents have their pros and cons. In its essence – the name “anti-icing reagent” indicates that the substance reacts with the environment, i.e. the ice cover.

Such a chemical process also depends on a number of factors, both external – natural-temperature and chemical.



a)



b)

Photo 1. Salt water quickly enters the concrete body, in case of existing waterproofing failures and expansion joints:

a) overpass on Babur Street (Tashkent); b) overpass on Bunyodkor street (Tashkent)

Deicing reagents can be liquid and solid and have different composition and chemical properties. When a solid anti-ice reagent hits the icy surface of snow or ice, these particles dissolve, forming a brine that has a freezing point below the freezing point of water. It is the solution of the anti-icing reagent, while its concentration is such, that melts the ice and prevents the occurrence of icy formations.

There are the following de – icing reagents:

Calcium chloride is a solid anti-icing agent in granules, packed in 25 kg bags. It is used for sprinkling roads from snow and ice in the winter season.

Icemelt is a solid de-icing agent modified calcium chloride. In bags of 25 kg. It is used for processing roads and streets, pedestrian areas and sidewalks in any temperature range up to –20 degrees C.

Marble chips – fine marble crushed stone with a grain size (fraction) of 2.5–5 mm – tempering form – in

bulk and in bags of 50 kg. It is used as an anti-icing agent in winter for sprinkling roads and pedestrian areas.

Granite chips – fine granite crushed stone with a grain size (fraction) of 2–5 mm – release form – in bulk and in bags of 50 kg. It is used as an anti-icing agent for the treatment of roads and pedestrian sidewalks.

Sand-salt (sand-salt mixture) – mixture of sand and technical salt – form of dispensing – loose and in 50 kg bags. It is used for sprinkling roads with ice in winter. It is a mixture of sand and salt in certain proportions, the lower the temperature and the greater the layer of ice, the higher the salt content of the sand-salt mixture. The sand and salt mixture is prepared by mixing in a 30/70 to 50/50 ratio. These products are used on roadways, bridges, and sidewalks. In the process of their application, they primarily prevent ice and also eliminate ice crusts.

Technical salt (sodium chloride) – NaCl – is available both in bulk and in bags. Used in boilers and as an anti-icing agent. It has a wide range of industrial applications. For example, in the oil industry, a salt solution is used to thaw the ground: a salt solution is poured into the cut holes, which penetrates into the soil under pressure and promotes the process of melting.

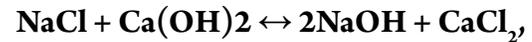
Rock salt is found in nature in the form of a mineral. Salt is mined and sold from regions rich in this mineral. The salt market is quite extensive, with the bulk of it coming from Belarus, Ukraine, and Central Asia.

On the roads of Uzbekistan, mainly technical salt is used, which is by far the cheapest and most effective remedy against ice.

Under alternating saturation and drying conditions, the concentration of NaCl solution in the pores of the cement stone reaches a maximum.

Such a solution comes into direct contact with the new formations in the fusion zone of their individual crystals. In this case both chemical and adsorptive action of Na⁺ and Cl⁻ ions is possible.

For example, in this case the process of



In recent years, we have surveyed many road bridges on the roads of the Republic of Uzbekistan, built in different years. The main data on these bridges are recorded in Table 1.

Table 1.

No.	Place bridge location	Bridge diagram	Bridge elements	Series No.	Installed damage
1.	M39 1333+14 km road	3 × 16.5	Ribbed span structures	Inv. 56D	Corrosion of concrete due to moisture ingress; destruction of the ends of the extreme beams due to corrosion of concrete; cracks 0.3 mm
			Rigel		concrete corrosion, the surface is covered with a network of cracks
2.	M39 1343+98 km road	1 × 12	Slab span	384/43	Corrosion of concrete due to water ingress; loosely installed on crossbars without supporting parts; incomplete filling of longitudinal joints with concrete
			Rigel		Corrosion of concrete due to water ingress
4.	M39 1357+80 km road	3 × 9	Slab span structures	384/43	Corrosion of concrete due to water ingress; incomplete filling of longitudinal joints with concrete
			Rigel		Poor quality concrete: loose, on coarse gravel
5.	M39 1358+22 km road	9 + 18 + 9	Slab span structures	384/43	Corrosion of concrete due to water ingress corrosion and exposure of reinforcement; insufficient support length;
6.					loosely installed on crossbars without supporting parts; longitudinal seams are not filled with concrete
			Rigel	Corrosion of concrete due to water ingress; insufficient strength of concrete	
7.	M39 1360+28 km road	3 × 19.7	Ribbed span structures	Inv. 56D	Corrosion of concrete due to water ingress; cracks up to 0.2 mm
			Rigel		Corrosion of concrete due to water ingress

From the data in table. Figure 1 shows that as a result of long-term operation, numerous damages appeared in

the structural elements of road bridges, reducing their carrying capacity and residual life (photo 2–13):

– numerous sections with degradation of the concrete structure as a result of constant ingress of moisture from the surface of the roadway were installed in the spans;

– unacceptable residual deflections were found in slab spans 18.0 m long due to the constant build-up of the asphalt layer on the roadway;

– in the ribbed span structures there are numerous cracks of a power nature. Due to the violation of the waterproofing, water with a salt concentration seeped into the slabs of the beams. One can see the

intensive development of salt corrosion of concrete in the cantilever part of the outer beams. The reduction in the cross-sectional area of the working reinforcement due to its corrosion reaches 40%;

– on the surface of the supports through faulty expansion joints, water constantly got from the roadway, as a result of which the concrete of the support bollards in 80% of the bridges has salt corrosion with a loss of strength of up to 50%. The bearing parts are corroded. There is surface corrosion and cracks in the concrete of the support body.



Photo 2. Traces of leaching and corrosion on the surface of beams and cast-in-place concrete



Photo 3. Corrosion of concrete at the ends of the extreme beams



Photo 4. Destruction of the lower part of the beam rib



Photo 5. Corrosion of the concrete crossbar and a network of cracks on it



Photo 6. Traces of leaching and corrosion of concrete on the surface of the beams



Photo 7. Reinforced concrete slabs installed without bearings



Photo 8. Traces of leaching and corrosion on the surface of the beams and abutments of the bridge



Photo 9. The support of the plates on the supports is made on roofing material of various thicknesses



Photo 10. Traces of leaching and corrosion of concrete on the surface of slabs of superstructures



Photo 11. Peeling off the protective layer of concrete and exposing the reinforcement in plate No. 12

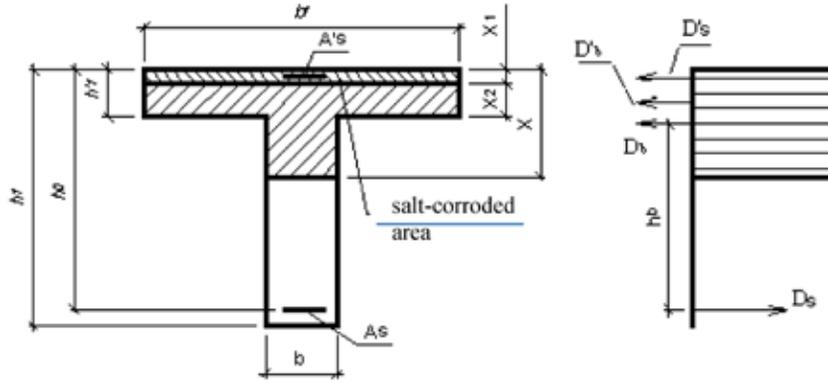


Photo 12. The longitudinal seams between the tiles are not filled with concrete



Photo 13. Traces of concrete leaching and corrosion on the surface of beams and supports

In the majority of cases [9; 10; 11; 12] in the main beam is exposed to salt corrosion roadway slab, and the corrosion of concrete in the tension zone at the edge is rare.



Picture 2. Diagram of the main beam

The maximum bending moment M_{cr} for determining carrying capacity, taking into account salt corrosion of concrete and rebar in concrete compressed zone is determined from the equation:

$$D'_b \left(h_0 - \frac{x_1}{2} \right) + D'_s \left(h_0 - \frac{a'_s}{2} \right) + D_b h_b - M_{cr} = 0 \quad (1)$$

Where D'_b и D_b – The resultant force in the compressed zone of the concrete susceptible and not susceptible to salt corrosion; D'_s – The resultant force in compressed reinforcement.

In general, when $x > h'_f$ (1) has the form

$$M_{cr} = R_{b1} b_f x_1 \left(h_0 - \frac{x_1}{2} \right) + R_b (h'_f - x_1) b_f \times \\ \times \left[h_0 - (h'_f - x_1) \times 0,5 \right] + \\ + R_b b (x - h_f) \left[h_0 - \frac{x - h_f}{2} \right] - R_s A'_s (h_0 - a'_s) \quad (2)$$

The height of the compressed zone x defined from the equilibrium equation

$$R_{b1} \times x_1 b_f + R_s A'_s + R_b b_f (h_0 - x_1) + \\ + R_b b (x - h'_f) - R_s A_s = 0 \quad (3)$$

here

$$x = \frac{R_s A_s - R_b b h'_f - R_b b_f (h_0 - x_1) - R_s A'_s - R_{b1} b_f x_1}{R_b b} \quad (4)$$

The value of the thickness of the damaged salt corrosion x_1 is determined by concrete test [10].

Consider the case of salt corrosion and concrete reinforcement in the compressed zone of the main beam (Pic. 2).

In the case where the zone is condensed in a shelf plate, $x < h'_f$ ultimate bending moment is defined similarly

$$M_{cr} = ax_1^2 + cx_1 + d \quad (5)$$

$$a = 0,5 R_{b1} b_f \left(1 - \frac{R_{c1}}{R_b} \right) \quad (6)$$

$$c = R_s A_s - R_s A'_s \quad (7)$$

$$d = ch_0 - \frac{c^2}{2R_b b_f} \quad (8)$$

In the case where there is corrosion of reinforcement in the compressed zone cross-sectional area A'_s is taken as [12]

$$A'_s = A'_{s\phi} \left(1 - 4 \frac{\delta}{d} \right) \quad (9)$$

where $A'_{s\phi}$ – sectional area of the reinforcement according to project, δ – bar corrosion depth, d – diameter of rebar.

Conclusions

The evaluation of the effect of salt corrosion of concrete and reinforcement on the bearing capacity of the elements of the superstructure. It is shown that the carrying capacity span structures subjected to salt corrosion is almost 2 times less than the carrying capacity span structures without salt exposure.

Thus, the proposed use of dependencies to determine the limit value of bending moments based on corrosion of reinforcement in concrete compressed zone.

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STUDY OF THE PROCESS OF ISOLATION OF MAGNESIUM COMPOUNDS FROM SERPENTINITE

Abstract. This paper provides data on the study of treatment of serpentinite with nitrate acid in the Karakalpak field. According to the chemical analysis, the composition of the raw material containing 33–35% MgO was determined. The results of the study showed that in the studied ranges of variation, the technological parameters of the MgO content in the liquid phase did not exceed 1.69 (in the ranges of temperature 40–80 °C), and with an increase in temperature by 95 °C, the content and yield of magnesium oxide increased by 2 times, respectively, by 2.99% and 24.4%.

Keywords: Serpentinite, magnesium nitrate, nitric acid, decomposition, acid leaching

Introduction. To obtain granular ammonium nitrate, which does not cake for long storage, a conditioning additive of magnesium nitrate is introduced into the ammonium nitrate solution before granulation, which, in an anhydrous state, can attach up to six water molecules to form magnesium nitrate hexahydrate – $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$. The most common magnesium compounds are volcanic formations – primary silicate and aluminosilicate rocks [1]. Based on this, the research aimed at the development of the

technology of processing serpentinite of the Karakalpak deposit into magnesium nitrate with the simultaneous production of nitrogen fertilizers is very relevant, which is one of the main tasks of this work.

Natural serpentinites, in addition to the main mineral serpentine $\text{Mg}_3\text{Si}_2\text{O}_5(\text{OH})_4$ (density 2.2–2.9 g/cm³, hardness 2.5–4), have impurities of different ore minerals giving the rock a different color. There are many serpentinite deposits in different regions of the country.

Composition of starting serpentinite:

- mass fraction of magnesium in terms of MgO 33.70–34.07%
- mass fraction of calcium in terms of CaO 0.86–0.70%
- mass fraction of silicon in terms of SiO₂ 40.26–39.98%
- mass fraction of iron in terms of iron oxide 8.83–8.75%

There are many ways to process serpentines [2]. For laboratory experiments, two schemes were chosen:

- 1) acid leaching at various temperatures → ammonization of the suspension after completion of the filtration → evaporation process before crystallization
- 2) thermal activation of serpentinite → acid leaching at temperature 70–95 °C → ammonisation of suspension till precipitation of iron oxides, aluminium → evaporation till crystallisation.

To select the optimal leaching conditions under which all valuable components are extracted from serpentinite as much as possible, the effect of the process temperature, its duration, the initial concentration of nitrate acid on the concentration of mag-

nesium and iron ions in the solution, the filtration coefficient and the sedimentation of the solid phase of the suspension were studied. Process parameters varied in the ranges nitric acid concentration 30–50%, process temperature 40–95 °C, process duration 30–240 min, nitric acid norm was 100% relative to the total metal oxide.

A mixing reactor was used for leaching: a flask reactor into a thermostat, where nitrate acid of a certain concentration was poured, the acid was supplied based on the calculation of the dissolution of all metals in serpentinite. Serpentinite of < 0.315 mm was then added when the desired temperature was reached. After acid treatment, the resulting suspension was separated from the insoluble silica residue by filtration.

From (Fig 1) it can be seen that in the studied ranges of variation, the technological parameters of the content of MgO in the liquid phase did not exceed 1.69 in the ranges of temperature 40–80 °C, and by increasing the temperature by 95 °C, ensure an increase in the content and yield of magnesium by 2 times, respectively, by 2.99% and 24.4%.

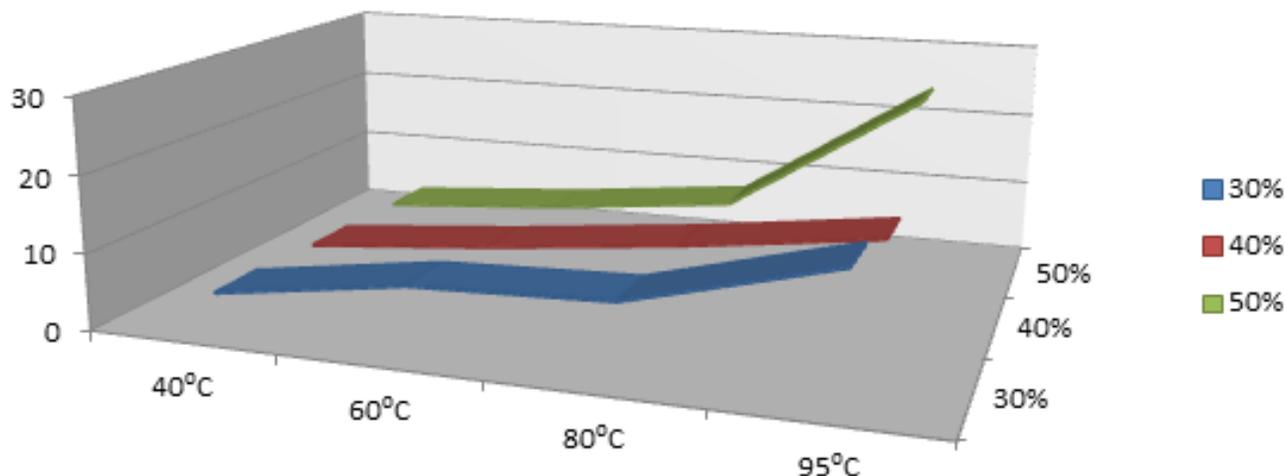


Figure 1. Degree of transition of MgO into liquid phase depending on decomposition temperature

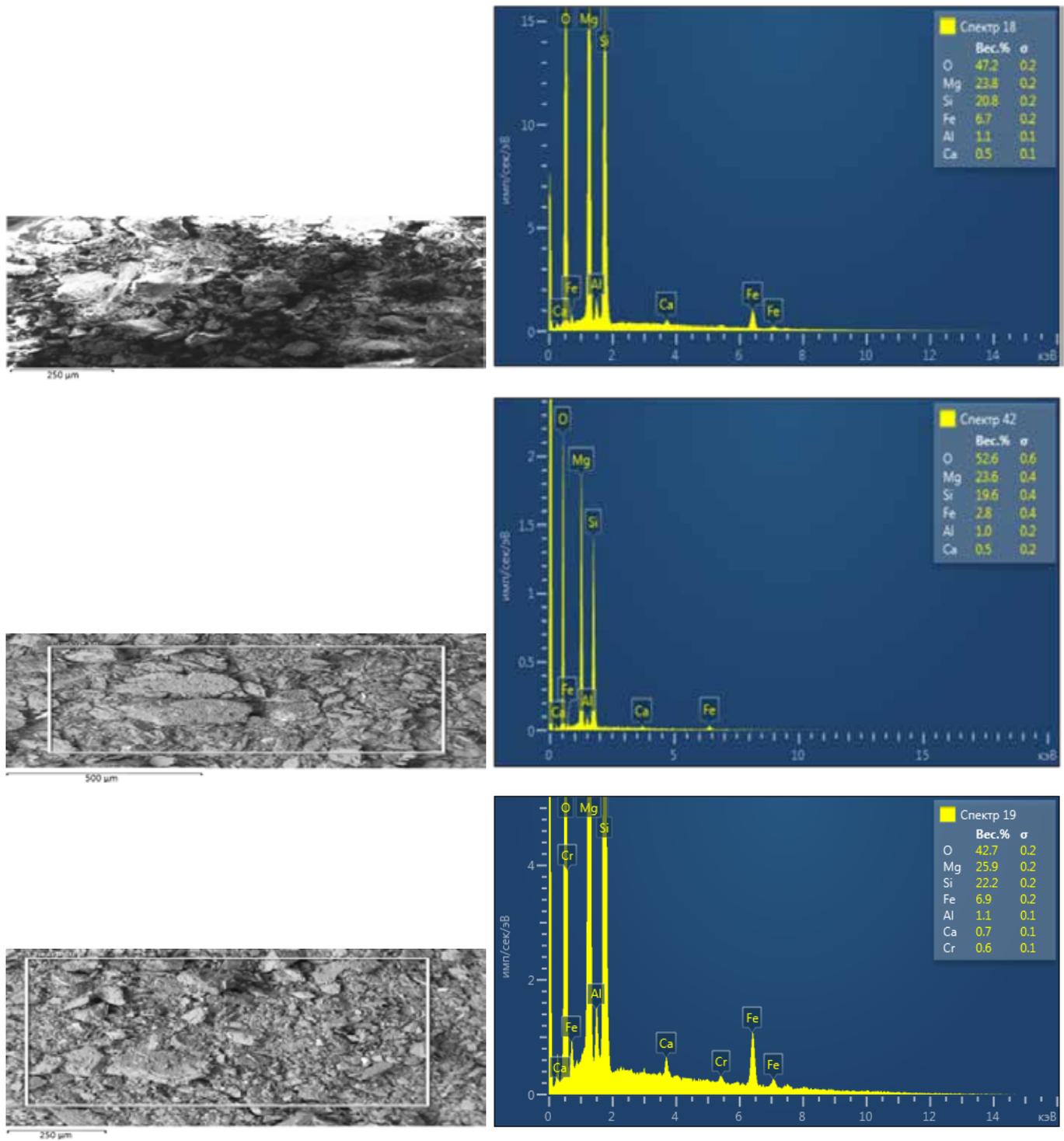


Figure 2. Energy-dispersed spectrum of samples. Initial and heat treated at 178 °C and 800 °C

Table 1.– Elemental Composition of Starting and Heat-Treated Serpentinite by Energy-Dispersive X-ray Spectroscopy

№	element	content by weight%		
		initial	heat treated	
			178 °C	800 °C
	O	52.6	47.18	42.69
	Mg	23.6	23.77	25.89
	Al	1.0	1.09	1.07
	Si	19.6	20.78	22.20
	Ca	0.45	0.47	0.67
	Fe	2.72	6.71	6.92

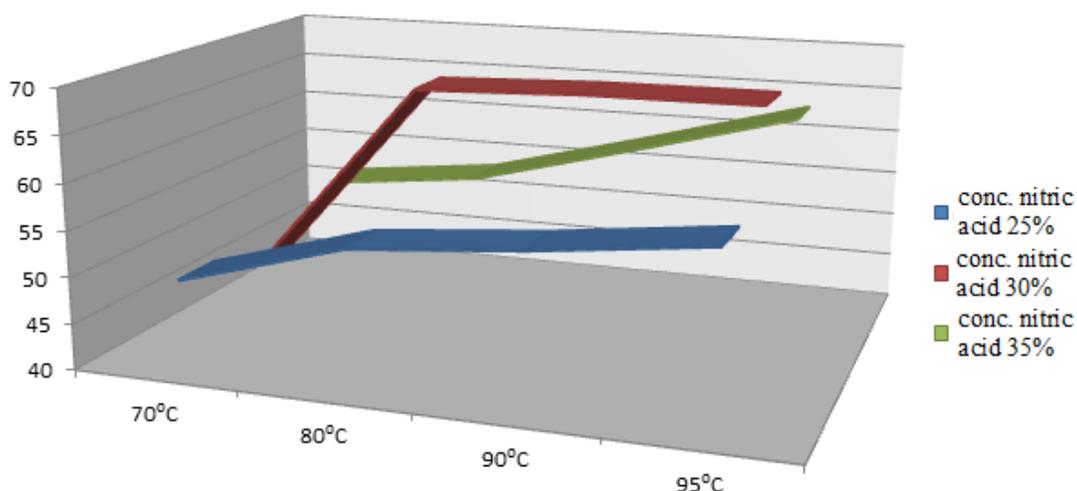


Figure 2. Degree of transition of MgO thermoactivated serpentinite liquid phase depending on temperature and concentration of nitric acid

These data show that the reactivity of magnesium minerals included in the composition of serpentinite with nitric acid is very low, in the ranges of varying technological parameters, it is not desirable from a technological and economic point of view. According to this, we have studied the effect of temperature and the duration of heat treatment of serpentinite on its reactivity of inorganic acids. The analysis results are shown in (table 1).

As can be seen from Table 1, the adsorption and crystallization waters are removed by calcination of serpentinite, and magnesium is converted to the active form. So at a temperature of 750 °C, the mass fraction of magnesium in terms of MgO increases by

2.45–2.8 at 800 °C, the mass fraction of magnesium increases by 9.63–9.98%.

Next, acid leaching of the calcined one according to the above method [3] was carried out. Process parameters varied in ranges of rate and concentration of nitric acid 100–120 and 25–35%, process temperature 70–95 °C, process duration 30–120 min.

Conclusions: As noted above, in the decomposition of the starting serpentinite, the content and yield of magnesium oxide in the form of magnesium nitrate are 2.99 and 24.4%, respectively, and in the use of heat-treated serpentinite, depending on the temperature and their value increases 8.46 and 70%.

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STOCHASTIC MODELING OF THE FUNCTIONING OF WIRELESS SENSOR NETWORKS

Abstract. The work is devoted to solving the problem of developing an information technology for monitoring environmental parameters based on the concept of the Internet of things, taking into account the uncertainty of information sources and the possibility of crisis situations. The principles of construction, technological solutions and directions for the development of systems for monitoring environmental parameters are analyzed. The advantages and disadvantages of known approaches are revealed and the feasibility of constructing mathematical models, methods and algorithms for compiling communication protocols for WSN wireless sensor networks with random access and relevant information technologies for monitoring environmental parameters to ensure high performance, quality and survivability of their functioning is proved. Improved stochastic models of the functioning of wireless sensor networks, which made it possible to assess the probability of signal collision and more effectively design communication protocols for the Internet of things Io T.

Keywords: wireless sensor networks, Internet of things, information technology, monitoring of environmental parameters.

Introduction

At present, there is an urgent need to control and measure almost all physical quantities and in all spheres of human activity. The use of sensors and associated communication nodes gives an idea of the universality of the problem of the development of wireless sensor networks (wireless network sensors, NSHV), in particular, in homes and buildings; industrial facilities; warehouses; in the natural environment in an environment affected by biological and chemical weapons; in cars and airplanes; on mobile intersections; at the bottom of the ocean; in rivers in combination with water energy, etc.

The development of electronics, information and communication technologies (ICT) provides grounds for implementing the idea of measuring and controlling any necessary physical quantities of the environment, industrial processes, management processes, monitoring, etc. Such a huge volume of applications of measuring technology requires solutions related to the technology of collecting, transmitting and processing information. Many network solutions have been developed and implemented based on previous experience in implementing ICT in the Internet of Things (IoT) concept, which are computer networks of physical objects (i.e. actually, things) that are equipped with technologies to interact with each other. These solutions are dominated by deterministic methods of access to the functioning of the network. The number of solutions is quite large and diverse: LAN, MAN, WAN, WLAN, Wi-Fi, mobile telephony, Bluetooth, ZigBee, etc. [1].

However, for a wide range of applications in modern monitoring information systems, deterministic solutions are of little use in view of large equipment costs, complexity, high energy requirements, complexity of algorithms, and a wide occupied radio band. All this significantly limits the possibility of their use. At the same time, the search for stochastic solutions opens up wide opportunities for additions that were previously little-used network solutions in some applications (for implementation that has not

been possible so far). They spread the category of solutions for modern applications, such as environmental monitoring, medical monitoring, etc. In this regard, the development of information technologies for environmental monitoring in the IoT concept is an urgent scientific and technical task [2].

The analysis of the principles of construction, technological solutions and the direction of development of monitoring systems in the concept of the Internet of Things (IoT), which consists of physical devices equipped with built-in technologies for interacting with each other or with the external environment using standard communication protocols, indicates that these devices can be automatically read, connected and carried into operation using highly intelligent interface without human involvement. Due to the intensive development of information and communication technologies, in particular, the spread of NSHV systems of wireless networks, the emergence of cloud technologies and computing, the development of technologies for interaction between machines of practical solutions. It is necessary to emphasize that the IoT concept encompasses three interrelated basic problems: ensuring information security (Internet of Things security); scaling the growing volume of technical devices and data (Scalability of the Internet of Things), and also taking into account the requirements for reducing energy consumption (Technical solutions of the Internet of Things and low-power design) [3].

Modeling of wireless sensor networks

Let's turn to stochastic models of WSN functioning to estimate the probability of signal collisions in the system [3]. Let's take a closer look at these models. Let A'_s be an event that will mean that there is no collision in the interval $[0, s]$ ($s > 0$). We take as $P(A'_s)$ the probability of no collision in the interval $[0, s]$. Consider the interval $[0, s]$, where $s > t_p$.

Suppose that $N(s) = j$, that is, the number of transmissions in the interval $[0, s]$ is equal to j $j \geq 1$. The random vector (U_1, \dots, U_j) of the time between transmissions is uniformly distributed on the set

$$\Omega_t^* = \{(u_1, \dots, u_j) : u_1 + \dots + u_j \leq s\}$$

with conditional density

$$f(u_1, \dots, u_j) / N(s) = j = j! / s^j$$

for $(u_1, \dots, u_j) \in \Omega_t^*$, as well as 0 beyond that.

Then the conditional density of the absence of a collision in the interval $[0, s]$, assuming $N(s) = j$, is equal to,

$$P(A_s' / N(s) = j) = P(U_1 > t_p, \dots, U_j > t_p) = \left(1 - \frac{jt_p}{S}\right)_+^j,$$

where the expression x_+ is defined as follows: $x_+ = x$ for $x \geq 0$ and $x_+ = 0$ for $x < 0$. The conditional probability of a collision in the interval of length s , where $s > t_p$, provided $N(s) = j$, is given by the expression so:

$$P(A_s / N(s) = j) = 1 - \left(1 - \frac{jt_p}{S}\right)_+^j. \quad (1)$$

The probability of a collision in the interval of length s ($s > t_p$) is determined by the expression:

$$(A_s) = \sum_{j=2}^{\infty} e^{-n\frac{t_p}{T}} \frac{\left(\frac{nS}{T}\right)^j}{j!} \left[1 - \left(1 - j\frac{t_p}{S}\right)_+^j\right], \quad (2)$$

where n is the number of nodes, T is the average time between node transfers, t_p is the p rotocol transfer time. Let's analyze the issues of the number of nodes that remain in collision in the interval s for the case $s > t_p$. We investigate the probability of a collision in the interval s for the case.

$$\begin{aligned} \sum_{\kappa=2}^{\infty} \kappa \sum_{j=2}^{\infty} e^{-n\frac{t_p}{T}} \frac{\left(\frac{nS}{T}\right)^j}{j!} \left(j\frac{t_p}{S}\right)^{\kappa-1} \left(1 - \frac{jt_p}{S}\right)_+^{j-\kappa} &\leq EY_s \leq \sum_{\kappa=2}^{\infty} \kappa \sum_{j=2}^{\infty} e^{-n\frac{t_p}{T}} \frac{\left(\frac{nS}{T}\right)^j}{j!} \left(j\frac{t_p}{S}\right)^{\lfloor \frac{\kappa+1}{2} \rfloor} \left(1 - \frac{t_p}{S}\right)_+^{j-\lfloor \frac{\kappa+1}{2} \rfloor} \\ \sum_{\kappa=2}^{\infty} \kappa \sum_{j=2}^{\infty} e^{-n\frac{t_p}{T}} \frac{\left(\frac{nS}{T}\right)^j}{j!} \left(j\frac{t_p}{S}\right)^{\kappa-1} \left(1 - \frac{jt_p}{S}\right)_+^{j-\kappa} &+ \left[\sum_{\kappa=2}^{\infty} \kappa \sum_{j=2}^{\infty} e^{-n\frac{t_p}{T}} \frac{\left(\frac{nS}{T}\right)^j}{j!} \left(j\frac{t_p}{S}\right)^{\lfloor \frac{\kappa+1}{2} \rfloor} \left(1 - \frac{t_p}{S}\right)_+^{j-\lfloor \frac{\kappa+1}{2} \rfloor} \right] \leq \\ D^2 Y_s &\leq \sum_{\kappa=2}^{\infty} \kappa \sum_{j=2}^{\infty} e^{-n\frac{t_p}{T}} \frac{\left(\frac{nS}{T}\right)^j}{j!} \left(j\frac{t_p}{S}\right)^{\lfloor \frac{\kappa+1}{2} \rfloor} \left(1 - \frac{t_p}{S}\right)_+^{j-\lfloor \frac{\kappa+1}{2} \rfloor} + \left[\sum_{\kappa=2}^{\infty} \kappa \sum_{j=2}^{\infty} e^{-n\frac{t_p}{T}} \frac{\left(\frac{nS}{T}\right)^j}{j!} \left(j\frac{t_p}{S}\right)^{\kappa-1} \left(1 - \frac{jt_p}{S}\right)_+^{j-\kappa} \right] \end{aligned}$$

Two dependences for the probability of collision are obtained (Fig.). Expression (1) describes the probability of a collision in a short continuation time t_p of the

Below are the models characterizing the lower and upper estimates of the conditional probability of the number of gears remaining in collision in the interval s , assuming that the number of gears in the transmission interval in the interval s ($s > t_p$) is equal to j . Let Y_s be the number of gears remaining in collision in the interval of length s .

Then

$$\begin{aligned} \left(j\frac{t_p}{S}\right)^{\kappa-1} \left(1 - j\frac{t_p}{S}\right)^{j-\kappa} &\leq \\ &\leq P(Y_s = \kappa / N(s) = j) \leq \\ &\leq \left(j\frac{t_p}{S}\right)^{\lfloor \frac{\kappa+1}{2} \rfloor} \left(1 - j\frac{t_p}{S}\right)^{j-\lfloor \frac{\kappa+1}{2} \rfloor} \\ &\sum_{j=2}^{\infty} e^{-n\frac{S}{T}} \cdot \frac{\left(\frac{nS}{T}\right)^j}{j!} \left(j\frac{t_p}{S}\right)^{\kappa-1} \left(1 - \frac{jt_p}{S}\right)_+^{j-\kappa} \leq \\ &\leq P(Y_s = \kappa) \leq \\ &\leq \sum_{j=2}^{\infty} e^{-n\frac{S}{T}} \cdot \frac{\left(\frac{nS}{T}\right)^j}{j!} \left(j\frac{t_p}{S}\right)^{\lfloor \frac{\kappa+1}{2} \rfloor} \left(1 - \frac{jt_p}{S}\right)_+^{j-\lfloor \frac{\kappa+1}{2} \rfloor}. \end{aligned} \quad (3)$$

Models characterizing the lower and upper estimates of the expected number of gears in collision and the variance of the number of gears in collision in the interval of length $D(Y_s) = \sqrt{D^2(Y_s)}$ are obtained. Let $s > t_p$.

provision of the protocol, determining the probability of undisturbed provision of the protocol. Expression (2) is derived using other properties of the Poisson pro-

cess regarding the probability of a collision in a sufficiently long transmission continuation time. The graphs illustrate the possibility of a collision depending on the number of nodes (sensors) for the set average time between message transmissions, and also shows the dependence on the average protocol transmission time if the number of nodes is set (Fig.). For the average time between node transmissions equal to 10 seconds, the maximum number of nodes at which quality is ensured at a probability level of no more than 10^{-2} is 10, and for the average time between node transmissions equal to 30 seconds, the maximum number of nodes is 50 [5; 6].

Conclusion

The work is devoted to solving an important and in-demand task—the development of information technology for monitoring environmental parameters in the modern concept of the Internet of Things (IoT) – taking into account the uncertainty of information sources and the possibility of crisis situations.

The paper analyzes the principles of construction, development of technological solutions and the direction of development of monitoring systems in the concept of the Internet of Things (IoT), consisting of physical devices, as a result of which the

shortcomings of known approaches are revealed and the expediency and necessity of creating mathematical models, methods, communication protocols of WSN networks with random access and corresponding information technologies for monitoring environmental parameters are proved. among them, to ensure high performance, quality and survivability by the creators of the systems [6; 7].

Stochastic models of the functioning of wireless sensor networks using randomized network parameters (with a variable number of nodes and random participation of nodes in separate groups of network nodes) have been improved, which made it possible to assess the possibility of signal collisions and design IoT communication protocols more efficiently. These models allowed us to estimate the probability of a signal collision: the maximum number of nodes providing transmission quality at the level of the probability of a collision not higher than 10^{-2} is 50 pcs., and the number of nodes involved in the collision was negligible compared to the average number of transmissions, in particular, the ratio of the average number of nodes involved in the collision to the average The number of gears is 10^{-7} .

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COMPARISON OF THE EFFECTIVENESS OF ANTI-DETONATION DEVICES IN INCREASING THE OCTANE NUMBER OF AUTOMOBILE GASOLINE

Abstract. Knocking is a very harmful phenomenon. Under detonation modes of combustion, engine power decreases, specific fuel consumption increases, engine operation becomes stiff and uneven. A high level of knock resistance of gasoline is achieved by increasing the proportion of high-octane components in its component composition.

The article presents the results of the influence of anisole, acetone and methyl tert-butyl ether on the anti-knock characteristics of local AI-80 motor gasoline.

Keywords: gasoline, oxygenates, anisole, acetone, MTBE, octane number, antiknock properties.

Enter. The sharp increase in demand for oil and gas products is causing various serious environmental problems in the world. Taking this into account, the Republic of Uzbekistan pays great attention to improving the quality of oil products and producing environmentally friendly oil products based on local raw materials and technologies.

The main part of the chemical poisoning of the environment is caused by gases emitted from internal combustion engines (IYoD). Due to the physical-mechanical processes in the engine cylinders, a complex composition consisting of more than 200 toxic components is released [1–2]. The table below shows the composition of toxic gases emitted from diesel and gasoline engines [3].

Taking carbon monoxide from these above components, they form compounds such as carboxyhemoglobin (HbCO), even at low partial pressures, since they exhibit hemoglobin-like properties. HbCO dissociation is 3600 times slower than oxyhemoglobin (HbO₂). In this case, hypoxemia occurs and oxygen permeability of tissues to the body decreases. At the same time, the constant presence of low concentration of carbon monoxide leads to a decrease in the sensitivity of the visual organs to light and colors, changes in the brain, disruption of mental reactions in a certain period of time, changes in the morphological indicators of the blood composition, such as erythrocytosis, polyglobulia. Constant exposure to carbon dioxide causes headaches, dizziness, rapid fatigue, emotional instability, and heart pain [4; 5].

Table 1.– The composition of automobile toxic gases

Component	Quantity,%	
	Gasoline engine	Diesel engine
<i>1</i>	<i>2</i>	<i>3</i>
Nitrogen	74–77	76–78
Oxygen	0.3–8.0	2–18

1	2	3
Water vapors	3.0–5.5	0.5–4.0
Carbon dioxide	5.0–12.0	1.0–10.0
Carbon monoxide	5.0–12	0.01–0.5
Nitrogen oxides	0.0–0.8	0.0009–0.5
Non-carcinogenic carbohydrates	0.2–3.0	0.009–0.5
Aldehydes	0.0–0.2	0.001–0.009
Saja	0.0–0.4 g/m ³	0.01–1.1 g/m ³
Benz(a)pyrene	Up to 10–20 µg/m ³	up to 10 µg/m ³

Along with the above, benzene in gasoline also poses various risks to human organs. Under the influence of high concentration of benzene, the areas of the human brain are greatly affected, and many times under the influence of low concentration of benzene, blood and circulatory organs are affected first. The effect of benzene in the blood leads to its accumulation in the brain, disruption of nucleic acid synthesis, damage to basic cells, disruption of their chromosomal structure, and a number of similar ef-

fects. There is a linear relationship between the concentration of benzene in motor gasoline and all of its unburned by-products, such as toxic gases, fuel system emissions, and refueling vapors. Every 1% increase in the amount of benzene in fuel causes a 0.7–0.8% increase in the content of toxic gases [6].

Based on the above information, it should be said that reducing the impact of motor vehicles on the environment is becoming one of the urgent problems of today.

Table 2. – Modern requirements for gasoline quality

Indicators	Requirements		
	Euro-3	Euro-4	Euro-5
Benzene content,%	1.0	1.0	1.0
Sulfur content,%	0.015	0.005	0.001
Amount of aromatic hydrocarbons,%	42	35	35
Amount of olefinic hydrocarbons,%	18	14	14
Oxygen content,%	2.3	2.7	2.7
Saturated vapor pressure, kPa	summer 70 winter 90	summer 70 winter 90	summer 70 winter 90

The fuel industry of Uzbekistan is making the transition to the requirements of European standards (Euro-3, Euro-4, Euro-5) regarding the anti-detonation and environmental properties of gasoline and diesel fuel (table 2) [7].

If we take gasoline as an example, in order to obtain gasoline that meets the above requirements (Euro-3, Euro-4, Euro-5), it is necessary not only to increase its octane number, but also to reduce the amount of sulfur, olefins and aromatic hydrocarbons (especially benzene) in gasoline. In addition, it is necessary to transfer excess aromatic hydrocar-

bons to isoparaffins, to add oxygen-retaining components, antioxidants, detergents and other necessary additives to gasoline.

If we look at the detonation process from a chemical point of view, the final fuel power is affected by the primary oxidation products of hydrocarbons – hydroperoxides and their highly active free radical decomposition products. The higher the formation of peroxide in this working mixture, the more glowing burning is observed [8; 9].

The main factor in the formation and intensity of detonation is the chemical composition of the fuel,

because the oxidation tendency of different groups of hydrocarbons is different under the same conditions. If the hydrocarbons in the fuel do not form enough peroxide under the conditions of oxidation before combustion, then decomposition due to glow does not occur, and as a result, the mixture is not affected by active substances, combustion takes place at a normal rate without detonation. Detonation stability or anti-detonation properties of hydrocarbons and fuels are determined in a special one-cylinder laboratory device [10; 11].

To increase the environmental safety and quality of gasoline, it can be achieved by changing their hydrocarbon and chemical composition. The use of antidetonators based on tetraethyllead (TEQ) is completely prohibited. After banning the inclusion of such types of antidetonators in gasoline, a lot of attention is being paid to testing and industrial production of mainly aliphatic and aromatic compounds [12].

Aliphatic-based compounds have become widespread in the United States. This was done by building new devices for catalytic cracking and alkylation processes. U.S. non-ethyl gasoline is characterized by a low amount of aromatic hydrocarbons. Their detonation stability is improved due to high-octane isoparaffins [13].

The aromatic route, aimed at reforming properly driven low-octane gasoline, was widely used in Western Europe and Russia. This type of deethylated brand gasoline consists mainly of aromatic hydrocarbons, and olefinic hydrocarbons are almost absent. Therefore, this type of gasoline exhibits a high level of stability along with high detonation stability and contains a small amount of sulfur compounds [14].

In recent years, the USA, Western Europe and Russia have started adding oxygen-preserving compounds such as ether and alcohol with a high octane number to gasoline [15].

The main purpose of this study is to study the effect of oxygenates such as acetone, anisole and butyl-carbitol on the octane number of domestic

AI-80 gasoline and to compare their octane number increase indicators.

Research object and methods. The research objects are: domestic industry gasoline AI-80, acetone, annisol, MTBE.

Modern and traditional methods of determining the physical and chemical properties of domestic AI-80 gasoline and its compositions with oxygenates were used in the research work.

The octane number of the obtained new gasoline samples was determined on a one-cylinder UIT-85 universal device (Fig. 1).

The study was conducted in the following sequence:

We determined the pressure of the first laboratory room using a barometer. Room pressure – 95200. This indicator is measured in *mm.sim.ust.* by the following calculation: $95200 - 190$ (according to the barometer passport) = 95010. From the table, the indicator of 95010 is 712.6 *mm.sim.ust.* was found to be equal to Barometric pressure is corrected for relative accuracy by the following equation:

$$K = (760 - R) \cdot 0.03 = (760 - 712.6) \cdot 0.03 = 1.42$$



Figure 1. One-cylinder UIT-85 universal device

Using this coefficient, we determined the degree of compression of gasoline samples of different octane numbers (O.S.) (79, 80, 81):

$$79 \rightarrow 15.69 + 1.42 = 17.11$$

$$80 \rightarrow 15.88 + 1.42 = 17.30$$

$$81 \rightarrow 16.05 + 1.42 = 17.47$$

Starting the experiment, the UIT-85 device was prepared for operation: first, the circulating oil was heated to 50–60 °C. After that, the engine was fired with the help of an electric generator. After the engine started, the circulating water was heated to a temperature of 96 °C. Then the standard gasoline

sample was checked and the detonometer reading was corrected to 55 ± 3 .

Obtained results and analysis. In our research, new gasoline compositions were obtained by compounding domestic AI-80 automobile gasoline with various oxygenates.

At the first stage of our research, domestic AI-80 gasoline with a composition of 1–7% acetone was taken, and the octane number of these gasoline samples was determined by the research method (T.U.). The results of the study are presented in Figure 2.

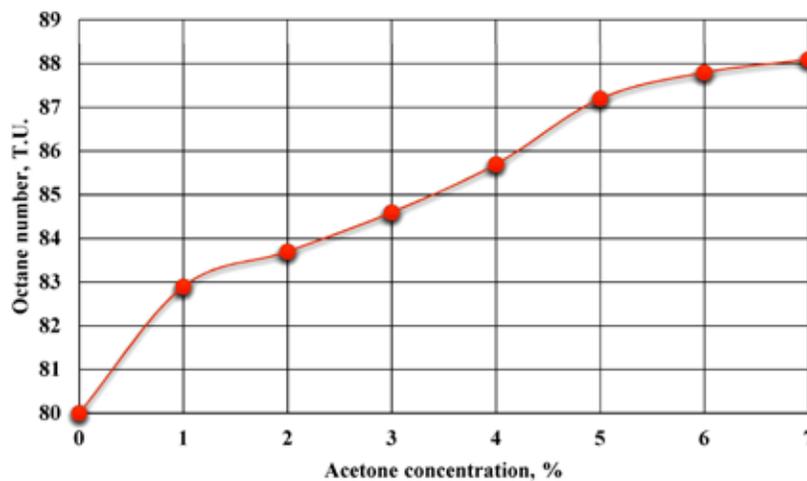


Figure 2. The level of acetone to increase the octane number of domestic AI-80 gasoline

As can be seen from Figure 2, with increasing acetone concentration, the octane number of gasoline compositions also increased. When the

concentration of acetone reached 7%, the octane number reached 88.1 points.

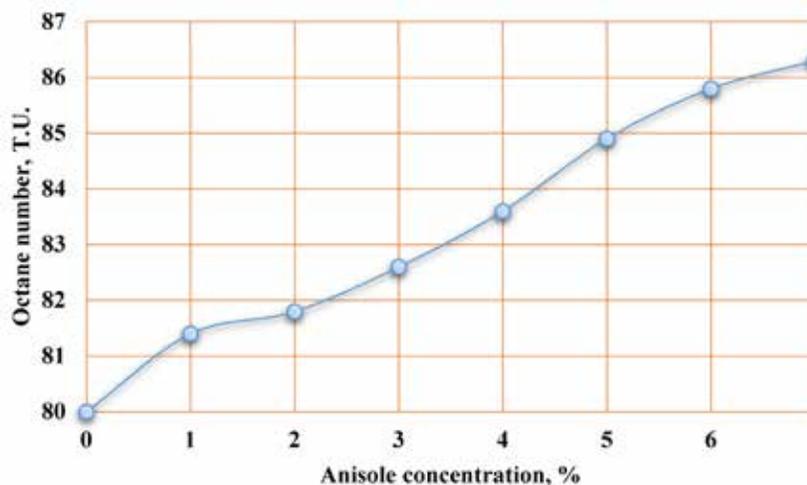


Figure 3. The octane rating of Annisol's domestic AI-80 gasoline

In the next step, we used anisole as an additive that increases the octane number. The degree of increase in the octane number of anisole is presented in Figure 3.

The results of the study increased the octane number of anisole by 6.3 points. This increase was lower than that of acetone. Analyzing these indica-

tors, this increase is not enough for the production of AI-92 and higher octane gasoline.

At the next stage of our research, we tried using the Butyl-carbitol compound. This oxygenate has been used on an industrial scale in the world in recent years. The results of the increase in the octane number of butyl carbitol are shown in the figure below (Figure 4).

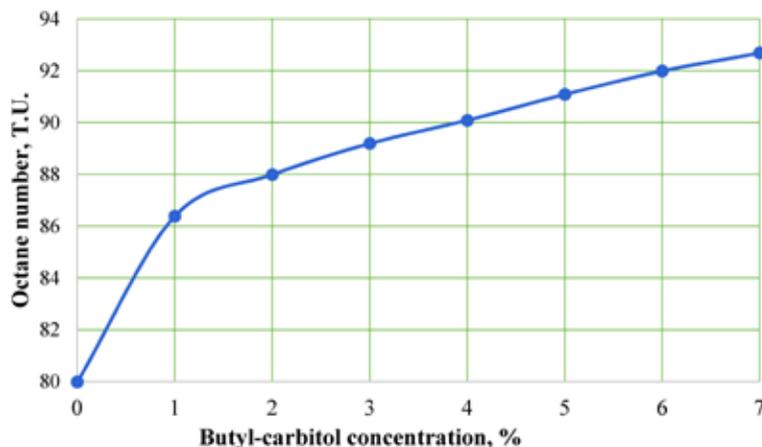


Figure 4. The level of Butyl-carbitol to increase the octane number of domestic AI-80 gasoline

The results of the study showed that the additives we studied significantly increase the octane number of domestic industrial gasoline. Among these tested

compounds, Butyl-carbitol showed a relatively high performance. When adding 7% to AI-80 gasoline, the octane number increased by 12.7 points to 92.7.

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Section 4. Chemistry

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1-O-METHYLEMODIN AND STIGMASTEROL COMPOUNDS FROM THE UNDERGROUND PART OF RUMEX PAMIRICUS RECH. F. (POLYGONACEAE)

Abstract. Two known compounds has been isolated from the chloroform fraction extract of *Rumex pamiricus* roots. Their structures were elucidated by extensive spectroscopic evidence and chemical methods. Qualitative analyses of compounds by TLC analysis were also evaluated.

Keywords: *Polygonaceae*, *Rumex pamiricus*, 1-O-methylemodin, stigmasterol. MS, ¹H and ¹³C NMR, DEPT, HSQC, HMBC, TLC.

1. Introduction

The basis of the technology for the isolation of 1-O-methylemodin and stigmasterol compounds is the extraction of raw materials with various organic solvents followed by chromatographic purification. Classical extraction methods (percolation and maceration) are time-consuming and laborious. The herb *Rumex pamiricus* Rech. f. belongs to the family of *Polygonaceae* and there are over 250 types on the earth and 16 types in Uzbekistan [1; 2].

2. Extraction and Methods

The roots of the herb *Rumex pamiricus* dried at room temperature, in shade. The pounded herb roots were first subjected to extraction in chloroform, then three times in 70% acetone hydrous solution. The acetone extract was distilled under vacuum, the remaining water solution was subjected to extraction with ethyl acetate. Ethyl acetate extracts were collected and were dehydrated by adding anhydrous salt Na₂SO₄. The dehydrated extract was filtered, its concentration increased under vacuum, the total phenols were precipitated by adding pure hexane to the condensed extract. The created precipitate was washed, and filtered and the extracted total phenols of chloroform and ethyl acetate fractions constituted 3.4% of the herb dry weight.

3. Isolation and Results

The chloroform fraction subjected with column chromatography on KSK silica gel, eluted with a mixture of extraction benzene–ethyl acetate: (50:1, 40:1, 30:1, 20:1 and 10:1). The structure of 1-O-methylemodin (1) and stigmasterol (2) was established on the basis of the analysis of the data of MS (Mass spectrometry), ¹H and ¹³C NMR spectra (Nuclear Magnetic Resonance), and of the DEPT (Distortionless Enhancement of Polarization Transfer), HSQC (Heteronuclear Single Quantum Coherence) and HMBC (Heteronuclear Multiple Bond Correlation) experiments. Qualitative analyses of major phenolics by TLC (Thin Layer Chromatography) analysis were also evaluated.

4. Conclusion

In our previous articles, the information provided about the chemical composition of *Rumex pamiricus* and *Rumex confertus* plants and their biological activities [3; 4; 5; 6; 7; 8]. Continuous studies on the chemical composition of *Rumex pamiricus* two known compounds has been isolated from the chloroform fraction extract of *Rumex pamiricus* roots. Their structures were elucidated by extensive spectroscopic evidence and chemical methods. Qualitative analyses of compounds by TLC analysis were also evaluated.

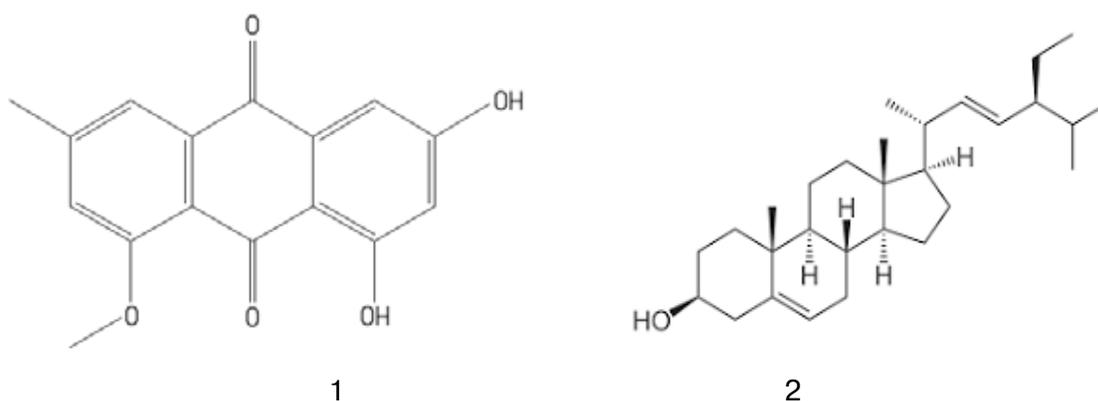


Figure 1. Chemical structures of isolated compounds: 1-O-methylemodin (1), stigmasterol (2)

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