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OBTAINING AND STUDYING THE PROPERTIES OF MODIFIED THREE-COMPONENT PHOSPHOGYPSUM INTERPOLYMER COMPLEXES AND COMPOSITES

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Abstract

The article is based on the preparation of a three-component composite mixture based on phosphogypsum, an interpolymer complex and humus and its study. It is known that phosphogypsum is a waste product of the chemical industry. The results of scientific research and practical experience have convincingly proved the technical feasibility and expediency of using phosphogypsum in the national economy instead of traditional types of natural raw materials. A brief description of phosphogypsum, promising areas of its processing and some statistical data are presented. The article deals with the use of a chemical meliorant based on phosphogypsum for effective fertilization in various soil and climatic zones for cereals, vegetables, industrial and other agricultural crops, to improve the soil structure. That the use of phosphogypsum as a chemical meliorant improves the chemical, physical and water-physical properties of saline soils.

Keywords: *interpolymer complex, phosphogypsum, humus, soil structure, chemical reclamation, salinization, gypsum, calcium dihydrate, calcium semi-hydrate, composite complex*

Introduction

The rapid pace of development of industry, energy, metallurgy, metalworking, chemical, petrochemical and other industries, as well as areas of engineering, construction and household activities entail the inevitable formation and accumulation of industrial waste on a global scale. And one of the mass types of waste is waste from the chemical industry (Ivanitsky V. V., Klassen P. V., Novikov A. A. et al., 1990).

The Decree of the President of the Republic of Uzbekistan dated February 13, 2021 No. PP-4992 "On measures for further reform and financial recovery of chemical industry enterprises, development of production of

chemical products with high added value" also mentioned the use of chemical industry waste as secondary raw materials (Decree of the President of the Republic of Uzbekistan 02/13/2021).

Analysis of literature on the topic. During the production of mineral fertilizers, various types of waste are generated, among which phosphogypsum is a waste product from the production of phosphate fertilizers (Kamilov K. U., 2005).

It should be noted that at present, in general, there is a significant layer of problems of a geo-ecological nature, associated, first of all, with extensive forms of environmental management, deterioration of the environmental situation for various reasons (Meshcheryakov Yu.G., Fedorov S. V. 2007; Best Available Techniques for Pollution Prevention), including the irrational management of many sectors of environmental management (Tayibi H., Choura M., López F. A., Alguacil J. A., López-Delgado A., 2009).

Currently, the dumps of "Samarkand-kimyo" OJSC contain more than 80 million tons of phosphogypsum and its amount continues to increase annually (in terms of calcium dihydrate) (Tayibi H., Choura M., López F. A., Alguacil J. A., López-Delgado A., 2009; Hilton, Julian, Phosphogypsum (PG): 2010). Monitoring studies of a phosphogypsum dump located on the territory of the Almalyk chemical mineral fertilizer plant of "Samarkand-kimyo" OJSC showed that old phosphogypsum has an identical chemical and phase composition (Fuleihan, Nadim F., 2011; Gennari R. F., Garcia I., Medina N. H., Silveira M. A.G., 2011).

Phosphogypsum in its chemical composition contains mainly oxides of calcium, sulfur and silicon with an admixture of oxides of iron, aluminum, magnesium, phosphorus, sodium and others. As can be seen from the table, the mass fraction of the main substance ($CaSO_4 \cdot 2H_2O$) in terms of dry dihydrate is 97%, the mass fraction of hygroscopic moisture is 16.4%, the content of water-soluble fluoride compounds in terms of fluorine is 0.12%. No toxic compounds of cadmium, arsenic, mercury, or lead were found in phosphogypsum (Larionov M. V., 2015; Kurbanova A. J. 2021; Kendivan O. D.-S., 2021).

Table 1. *Results of chemical analysis of phosphogypsum samples from Ammophos-Maxam OJSC*

Name of indicators	Phosphogypsum (stale). waste of OJSC	
	density g/cm³	density g/cm³
1. P_2O_5 general	2.00	1.39
2. SO_3	44.33	44.95
3. CaO	29.81	31.33
4. Fe_2O_3	0.29	0.64
5. F general	0.42	0.39
6. SiO_2	13.75	12.44
7. Al_2O_3.	0.31	0.58
8. Fe_2O_3	0.29	0.64
9. MgO	traces	0.5
Insoluble residue	9.09	7.78

For samples of old phosphogypsum (waste from "Samarkand-kimyo" OJSC), the specific effective activity of natural radionuclides was determined, on the basis of which a sanitary and epidemiological conclusion was given that the phosphogypsum samples comply with SP No. 202 dated 02/03/2012. "Sanitary and epidemiological requirements for ensuring radiation safety" and phosphogypsum can be used in economic activities without restrictions. Toxicological indicators were determined for phosphogypsum samples, which showed that the toxicity value of phosphogypsum aqueous filtrate in an experiment on laboratory animals (white mice) corresponds to the 4th hazard class. The total toxicity index of a phospho-

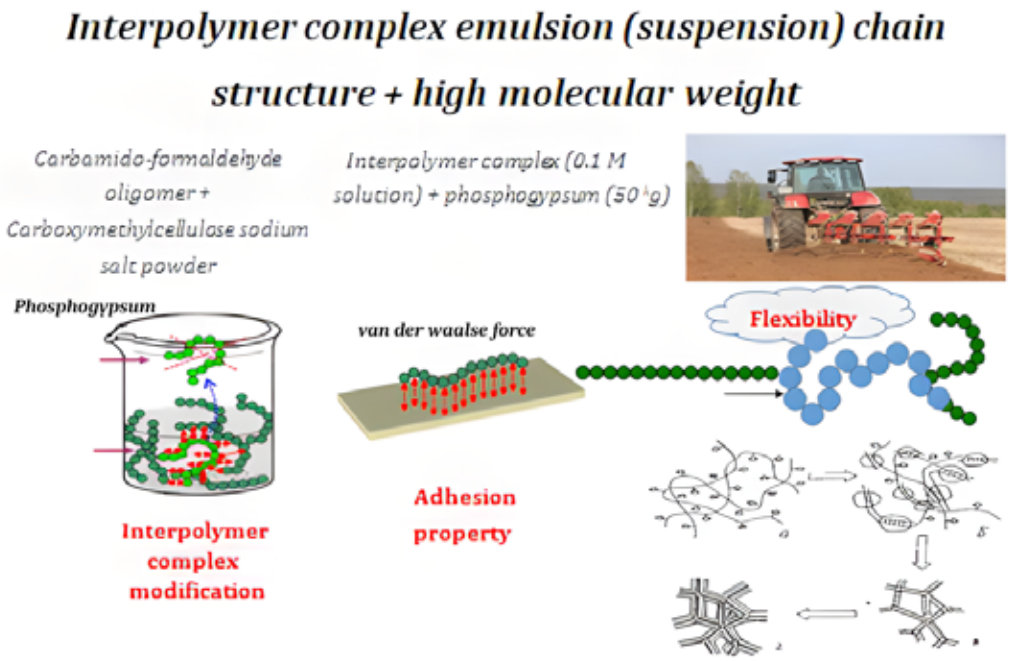
gypsum sample is 7.53 units, which, according to GOST 30774–2001, classifies this waste as hazard class 5 (not hazardous).

Research methodology. The total area of solonetzic soils in the Republic of Uzbekistan is more than 2 million hectares, of which about 50% of the irrigated lands of Khorezm and the Republic of Karakalpakstan have been subject to salinization and loss of nutrient reserves. For this reason, agricultural yields on these lands have decreased by almost 2 times.

To increase the yield of agricultural crops on alkaline and saline soils, it is necessary to increase calcium reserves in them by adding calcium-containing chemical mixtures (gypsum, phosphogypsum). Under the conditions in the above areas, the most effective chemical mixture is phosphogypsum, obtained as an industrial waste from phosphorus production. Today, the "Samarkand-kimyo" OJSC plant (Samarkand, Uzbekistan) has accumulated a huge amount (more than 60 million tons) of phosphogypsum, which consists mainly of calcium sulfate dihydrate ($CaSO_4 \cdot 2H_2O$), phosphogypsum also includes phosphates (1.3–2.9%) (Kurbanova A.Dj., 2021; Allaev Zh., 2021).

It should be noted that our country traditionally occupies one of the leading places in the Central Asian market of phosphate raw materials (Temirov G. B., Alimov U. K., Seitnazarov A. R., Namazov Sh. S., Kaimakova D. A., 2021). In Uzbekistan, the largest enterprise in the mineral fertilizer industry is "Samarkand-kimyo" OJSC.

Figure 1. *Preparation of modified three-component phosphogypsum-interpolymer complexes and composites*



The problem of using phosphogypsum as a secondary raw material for the production of liquid products has been relevant since the 60 s. XX century. The results of numerous studies and practice have convincingly proven the technical feasibility and feasibility of using phosphogypsum in the national economy instead of traditional types of natural raw materials (Eshmatov A. M., 2021). This is due to the content of phosphogypsum from 80 to 98% gypsum, which allows it to be classified as gypsum raw material. Here we should note the most promising areas for using phosphogypsum as a valuable large-scale secondary resource:

- in agriculture for chemical reclamation of acidic and saline soils and composting with organic fertilizers;
- in the cement industry as a mineralizer – an additive to the raw material mixture and as a setting rate regulator – instead of natural gypsum;

- for the production of gypsum binders and products, filler in the production of plastics and glass;
- in the construction of highways, construction of buildings and structures;
- in the development of marine and coastal zones;
- for the production of sulfuric acid, etc.

Analysis and results. Thermal analysis. Phosphogypsum, one of the components of the three-component mixture, was heated to 300 degrees Celsius and subjected to heat treatment.

Quantitative analysis. A 0.1 m/L solution of the interpolymer complex (derived from (1.1;1.2;1.3;1.4;1.5):1 oligomeric urea-formaldehyde and carboxylmethylcellulose) was prepared and mixed with spraying to obtain phosphogypsum masses.

Humus (phosphogypsum-humus 5:1) was added to the resulting phosphogypsum mass and a three-component composite mixture was formed.

To improve the structure of the soil, it is desirable to include various structural formers in its composition. For this purpose, we developed and carried out laboratory processing of a three-component composite mixture that positively changes the structure of the soil.

Phosphogypsum is used for alkalization, desalinization of soil and reclamation of solonetzes. Phosphogypsum is effectively used on soils with a high sodium content as fertilizing ameliorants (1 ton of Phosphogypsum contains about 10 kg of phosphorite), for composting with biological products and organic fertilizers.

We have obtained a three-component composite mixture taking into account some of the above-mentioned features.

The effectiveness of using phosphogypsum in heat treatment will be relatively higher compared to using it only by itself as a soil stricture improver, which we have concluded based on our research.

Results and discussion. In connection with the above, laboratory and field studies were carried out using a three-component composite mixture (TCMC) as soil structure-formers. TCCC is introduced into the soil along with plowing, during which microelements, Ca, S, are introduced into the soil, a water-saving process with an interpolymer complex occurs, and the supply of humus leads to an increase in soil fertility.

Conclusions and suggestions. According to forecasts, by 2040 the amount of waste could double. The issue of bringing phosphogypsum to a state in which it would be possible to use it entirely or assimilate waste into the natural environment without damaging its natural state is more relevant than ever. Thus, modern problems of environmental management and waste generation are interconnected, which requires a phased and at the same time comprehensive solution.

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