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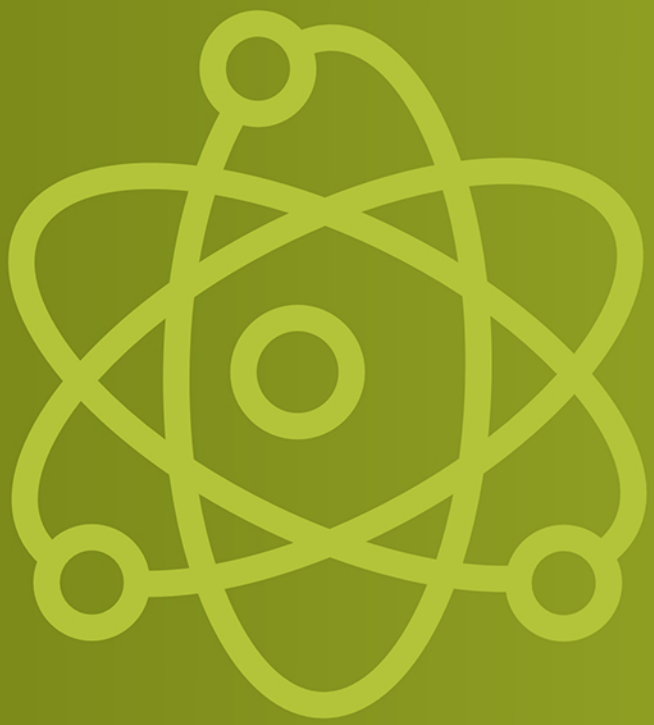

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PRODUCTION AND STUDY OF THREE-COMPONENT MIXTURES OF PHOSPHO-POLYMER COMPLEXES

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Abstract

The article is based on the preparation of a three-component composite mixture (TCCM) based on phosphogypsum, an interpolymer complex and humus and its study. It is known that phosphogypsum is a waste 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 directions of its processing and some statistical data are presented.

The use of TCCM based on phosphogypsum for effective fertilizing in various soil and climatic zones for cereals, vegetables, industrial and other agricultural crops, to improve the structure of the soil. That the application of TCCM as a chemical structure of soil formers gives an improvement in 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. Currently the Republic of Belarus is solving the problem of processing a by-product — phosphonyls, formed in the process of phosphoric acid production. The issue of utilization of phosphonyls is becoming more and more relevant, and there are several reasons for this: transportation of phosphonyls to dumps and its storage require large capital investments and operating costs; when

creating phosphonyls dumps, it is necessary to alienate large areas, sometimes even cultivated land; storage of this material in dumps, even with the neutralization of soluble impurities and with the observance of dump operational rules causes irreparable harm to the environment. There are known studies of scientists on the use of phosphonyls for road construction as a binder for strengthening soils, foundations and repair work. The paper presents the results of experiments on obtaining road-building materials from this waste without converting it into a binder. Based on the research, a technology for the preparation of asphalt concrete mixtures with the use of mineral powder in the form of phosphonyls dihydrate has been developed (Kovalev Ya. N., 2021).

Thus, in the production of mineral fertilizers, various types of waste are formed, among which phosphonyls is the waste from the production of phosphorus fertilizers (Komilov K. U., 2005). It should be noted that at present, in general, there is a significant layer of agroecological problems associated primarily with extensive forms of environmental management, environmental degradation for various reasons. The shortcomings of common equipment for utilization of phosphonyls when processing it into semi-aqueous gypsum have been analyzed. Specific energy consumption per ton of produced construction gypsum in different equipment is shown. Calcination duration is compared. The reasons for the uncompetitively of the process of production of construction gypsum compared to the production of natural gypsum stone are analyzed. Two problems are considered. The first — common equipment for burning construction gypsum is energy-intensive. The second is the established practice of washing impurities in phosphonyls with water. At the same time, energy consumption increases several times due to the need for energy consumption for moisture evaporation. It is theoretically reasonable to carry out the firing in a suspended state. The firing time is a few seconds. The experimental studies show the possibility of producing construction gypsum by firing in a suspended state (Veshcheryakov Yu. G., 2007), including the irrational management of many branches of environmental management. The production of phosphoric acid from natural phosphate rock by the wet process gives rise to an industrial by-product called phosphonyls (PG). About 5 tons of PG are generated per ton of phosphoric acid production, and worldwide PG generation is estimated to be around 100–280 Mt per year. This by-product is mostly disposed of without any treatment, usually by dumping in large stockpiles. These are generally located in coastal areas close to phosphoric acid plants, where they occupy large land areas and cause serious environmental damage. PG is mainly composed of gypsum but also contains a high level of impurities such as phosphates, fluorides and sulphates, naturally occurring radionuclides, heavy metals, and other trace elements (Tayibi H., 2009).

Currently, there are more than 60 million tons of phosphonyls in the dumps of JSC Ammo Phos-Maxam and its quantity continues to increase annually (in terms of calcium dihydrate). There are a number of factors that an operator should consider before pursuing wet or dry stacking of the phosphonyls by-product from a phosphoric acid plant. In addition to process considerations, important factors include the climatologic regime, water balance considerations, hydrogeology, topography, capital cost, operating cost (and maintenance), closure costs (and handling of drainable pore water), availability (or scarcity) of a fresh water source, distance from the plant to the disposal site (and viability of dry versus wet transport methods), P_2O_5 recovery, impacts on the environment (from leakage, dusting, accidental spills, etc.) and applicable regulations (Nadim F., 2021). Monitoring studies of the phosphonyls dump located on the territory of the Almalyk chemical plant of mineral fertilizers of JSC Ammo Phos-Maxam showed that the stale phosphonyls has an identical chemical and phase composition. Phosphonyls stand for the chemical origin gypsum generated in fertilizers production, in which phosphate rock is attacked by sulfuric acid resulting in phosphoric acid (H_3PO_4) and phosphate fertilizers. Phosphonyls is not a commercial product and it is stocked in large open areas or accumulated in lakes inducing to a major environmental problem due to the presence of toxic and radioactive elements. The increasing world agricultural demand is the real responsible for the severity of this environmental problem. Nevertheless, there

are some possibilities for the application of this reject material, such as civil construction, waste water treatment, and in cultivated lands, etc. In the agriculture the phosphonyls is commonly used as a nutrient source due to its large amounts of phosphorus, calcium and sulfur. (Gennari R.F., 2011). Phosphonyls 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 (CaSO4 * 2H2O) in terms of dry dihydrate is 97% (Larionov M.V., 2015), the mass fraction of hygroscopic moisture is 16.4%, the content of water–soluble fluoride compounds in terms of fluorine is 0.12%. No impurities of toxic compounds of cadmium, arsenic, mercury, lead were found in the composition of phosphonyls (Kurbanova A. Dj., 2021).

Table 1. *Results of chemical analysis of phosphonyls samples of JSC "Ammo Phos-Maxam" Almalyk, Uzbekistan*

Name of indicators	*Phosphonyls (stale), dump of Almalyk-Maxam OJSC*	
	density g/cm³–2.3	*density g/cm³–2.4*
1. $P_2O_{5\ common}$	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_{common}	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

The specific effective activity of natural radionuclides was determined for the samples of stale phosphonyls (waste of JSC Ammo Phos-Maxam), on the basis of which a sanitary and epidemiological conclusion was given that the samples of phosphonyls correspond to SP No. 202 of 03.02.2012. "Sanitary and epidemiological requirements for radiation safety" and phosphonyls can be used in economic activities without restrictions. Toxicological parameters were determined for phosphonyls samples, which showed that the toxicity of phosphonyls aqueous filtrate in an experiment on laboratory animals (white mice) corresponds to the 4th hazard class. The total toxicity index of the phosphonyls sample is 7.53 units, which according to GOST 30774–2001 refers this waste to hazard class 5 (not dangerous).

The total area of saline 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 undergone salinization and loss of nutrient reserves. For this reason, the yield of agricultural crops on these lands has decreased by almost 2 times.

To increase the yield of agricultural crops on saline and saline soils, it is necessary to increase calcium reserves in them by introducing calcium-containing chemical mixtures (gypsum, phosphonyls). In the conditions of the higher given areas, the most effective chemical mixture is phosphonyls, obtained as an industrial waste of phosphorus production (Kendivan O.D.-S., 2021). Today, a huge amount (more than 60 million) has accumulated at the Ammo Phos-Maxam plant (Almalyk, Uzbekistan). tons) phosphonyls, which consists mainly of calcium sulfate dihydrate (CaSO4 * 2H2O), phosphonyls also includes phosphates (1.3–2.9%) (Komilov K.U., 2021).

It should be noted that our country traditionally occupies one of the leading places in the Central Asian market of phosphate raw materials (Allayev J., 2021). In Uzbekistan, the largest enterprises in the mineral fertilizers industry are "Ammo Phos-Maxam" (Eshmatov A.M., 2021).

The problem of using phosphonyls as a secondary raw material for the production of liquid products has been relevant since the 60 s of the XX century (Temirov G. B., 2021). The results of numerous studies and practice have convincingly proved the technical feasibility and expediency of using phosphonyls in the national economy instead of traditional types of natural raw materials. This is due to the content of 80 to 98% gypsum in phosphonyls, which allows it to be attributed to gypsum raw materials. Here it should be noted the most promising areas of use of phosphonyls as a valuable large-tonnage 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 mixture and as a setting speed regulator — instead of natural gypsum;
- for the production of gypsum binders and products, filler in the production of plastics, 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.

Research methods

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

Quantitative analysis. A 0.1 m/l solution of an interpolymer complex (obtained on the basis of 1:1 oligomeric urea formaldehyde and carboxyl methylcellulose) was prepared and mixed with spraying to the resulting phosphonyls mass.

Discussion

Humus was introduced into the resulting phosphonyls mass (phosphonyls-humus 5:1) and formed a three-component composite mixture.

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

Phosphonyls is used for: cleavage, soil salinization and reclamation of salt pans. Phosphonyls is effectively used on soils with a high sodium content. Mixed with lime for reclamation of acidic soils. As fertilizer ameliorants (1 ton of phosphonyls 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 features.

The efficiency of using phosphonyls in heat treatment will be relatively higher compared to the fact that it dies only by itself as an improver of soil stricture, which we came to on the basis of our research.

Results and discussion. In connection with the above, laboratory and field studies were carried out using a three-component composite mixture (TCCS) as soil structurers. TKCC is introduced into the soil together with plowing, in which trace elements, Ca, S, are introduced into the soil, a water-saving process with an interpolymer complex occurs, and the intake of humus leads to an increase in soil fertility.

Conclusion

According to forecasts, the amount of waste may double by 2040. The question of bringing phosphonyls to such a state that it is possible to use it entirely and it is cost-effective, or assimilate waste in the natural environment without compromising its natural state is more relevant than ever.

Thus, modern problems of environmental management and waste generation are interrelated, which requires a step-by-step and at the same time a comprehensive solution.

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