INVESTIGATION OF THE PHYSICO-CHEMICAL COMPOSITION OF BIOSLUDGE FROM THE UZGTL PLANT

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As a result of rapid industrial development, the volume of waste with various compositions and properties is increasing. Conventional storage or disposal of such waste leads to environmental problems and results in the underutilization of valuable components contained within it. Therefore, processing industrial waste as secondary raw materials, especially obtaining mineral and organo-mineral fertilizers from materials containing essential macroelements for plants, is one of the current relevant research directions.

The composition of biosludge generated at the UZGTL plant is of particular interest from this perspective. Along with a high proportion of organic matter, the presence of elements such as nitrogen, phosphorus, potassium, silicon, calcium, and magnesium makes it possible to evaluate biosludge not merely as simple waste, but as a potential secondary raw material for processing. Initial analytical data indicate that the biosludge contains approximately 50% carbon, 5.55% nitrogen, 1.82% phosphorus, and 1.36% potassium. This composition clearly demonstrates the potential of biosludge, particularly as a nitrogen-rich component.

Evaluating the fertilizer value of biosludge solely by the total amount of elements present is insufficient. One critical aspect is the chemical form in which nutrient elements exist and their degree of assimilation by plants. In particular, a portion of the phosphorus may be present in difficultly soluble mineral or organic compounds. Therefore, processing biosludge using mineral acids enables the chemical activation of certain components within its composition and converts nutrient elements into assimilated (plant-available) forms.

In this process, the mineral acid not only acts upon the mineral components of the biosludge but also serves as an active reagent for processing low-grade phosphorites. As a result of the acid decomposition of calcium phosphates—the primary component of low-grade phosphorite—relatively soluble forms of phosphorus are formed. For example, the reaction of calcium phosphate with nitric acid can be represented as follows: $Ca_3(PO_4)_2 + 4HNO_3 \rightarrow 2H_3PO_4 + 3Ca(NO_3)_2$. The phosphoric acid produced in this step serves as a plant-assimilable source of phosphorus in subsequent stages.

Although biosludge itself contains phosphorus and potassium, it is advisable to utilize additional sources of phosphorus and potassium to adjust their concentrations to meet complex fertilizer standards. In this regard, the use of low-grade phosphorite is of significant economic and technological importance. Instead of expensive high-grade phosphate raw materials, co-processing local low-grade phosphorite with biosludge allows two types of secondary or relatively low-cost raw materials to be converted into useful products.

The introduction of a potassium-bearing component serves to improve the macroelement ratio of the resulting product. Consequently, the nutritional value of the complex fertilizer is increased due to the nitrogen in the biosludge, the phosphorus derived from phosphorite, and the additional potassium source. In such an approach, each raw material performs a distinct role: biosludge acts primarily as a source of

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nitrogen and organic components, phosphorite as a source of phosphorus, and the potassium raw material as a source of potassium.

The efficiency of the process depends primarily on the completeness of the interaction between the mineral acid and the solid raw material. If the acid concentration is excessively low, the decomposition of phosphorite may be insufficient. Conversely, an excessive consumption of acid increases the cost of the technological process and heightens the demand for the neutralization stage of the finished product. Therefore, when selecting optimal technological conditions, not only the transfer of nutrient elements into solution must be taken into account, but also reagent consumption and the physical properties of the final product.

A promising scheme for the comprehensive processing of biosludge includes raw material preparation, chemical activation with mineral acid, interaction with low-grade phosphorite, enrichment with a potassium component, neutralization when necessary, and final drying. At the end of the process, along with the nitrogen, phosphorus, and potassium content, parameters such as moisture, pH value, available phosphorus forms, and other agrochemical indicators of the resulting product must be evaluated.

Thus, the structural characteristics of UZGTL biosludge allow it to be considered a promising secondary raw material for producing mineral fertilizers. Scientific foundations for obtaining complex NPK fertilizers are established by utilizing its nitrogenous components, converting phosphorus into an assimilable form using low-grade phosphorite and mineral acid, and enriching the product with potassium. This approach simultaneously reduces industrial waste, makes efficient use of local raw material resources, and yields essential fertilizer products for agriculture. Therefore, conducting deeper research into the comprehensive processing of UZGTL biosludge with mineral acids, low-grade phosphorites, and potassium raw materials is highly promising from both scientific and practical standpoints.

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