



## STUDY OF THE EFFECT OF LIMESTONE PURIFICATION, DEFLUORINATION, AND DESULFATIZATION DURING THE EXTRACTION PROCESS OF PHOSPHORIC ACID BASED ON CENTRAL KYZYLKUM PHOSPHORITES

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### ABSTRACT

*This scientific investigation presents the experimental findings on the neutralization process of purified extraction phosphoric acid (EPA), obtained after fluoride and sulfate removal using calcium carbonate, as well as concentrated acid derived from evaporation. The research focuses on producing high-quality defluorinated phosphorus-based simple fertilizers containing calcium and magnesium phosphates through the neutralization of phosphoric acid with calcium carbonate.*

Phosphorus fertilizers extensively applied in the agriculture sector of the Republic mainly include ammophos produced from Central Kyzylkum phosphorites and ordinary superphosphate. It is widely recognized that ammophos lacks calcium in its composition. Continuous utilization of ammophos gradually reduces the quantity of mobile calcium and magnesium in soils, leading to deficiencies of these essential elements in plants and living organisms. Consequently, soil structure deteriorates, crop productivity decreases, and various biological disorders emerge in living systems [1–3].

The territory of Uzbekistan possesses substantial reserves of indigenous non-metallic mineral raw materials rich in calcium and magnesium carbonates that satisfy industrial technological standards [4]. However, these resources are not comprehensively processed. Their application in the manufacture of calcium- and magnesium-containing phosphate fertilizers is therefore of considerable industrial significance. In this regard, the process of obtaining simple phosphate fertilizers by neutralizing extraction phosphoric acid with limestone raw materials was thoroughly examined.

Initially, the influence of preliminary thermal treatment of limestone feedstock on the foaming behavior during EPA neutralization was investigated. Limestone samples were thermally processed within the temperature range of 100–1050°C, and the chemical composition of the resulting products was determined.

During neutralization of EPA with untreated limestone material, the foaming intensity increased to 335% within 5 minutes, decreased to 115% after 15 minutes, and required approximately 45 minutes for complete foam suppression. In contrast, when thermally treated limestone products were used, the foaming level decreased substantially. Specifically, raw materials treated at 500°C, 700°C, 800°C, and 950°C exhibited foaming intensities of 288%, 215%, 124%, and 92%, respectively, within 5 minutes, while after 15 minutes the values declined to 80%, 54%, 12%, and 0%, respectively.

To minimize foaming during EPA neutralization, both untreated limestone and limestone thermally activated at 800°C were employed. Extraction phosphoric acid containing approximately 17% P<sub>2</sub>O<sub>5</sub> was neutralized in the presence of 1% ammonium nitrate, followed by evaporation of the suspension and drying at temperatures between 95–100°C.

Neutralization of ~17% P<sub>2</sub>O<sub>5</sub> EPA using untreated and thermally treated limestone (800°C) in the presence of ammonium nitrate (1%), followed by drying of the suspension at 95–100°C, resulted in calcium- and magnesium-phosphate fertilizers with the following composition (wt.%): total P<sub>2</sub>O<sub>5</sub> – 48.05 and 47.88; assimilable P<sub>2</sub>O<sub>5</sub> – 47.26 and 46.98; water-soluble P<sub>2</sub>O<sub>5</sub> – 44.18 and 43.96; free P<sub>2</sub>O<sub>5</sub> – 2.05 and 1.96; CaO – 20.77 and 20.38; MgO – 2.29 and 2.23; nitrogen – 0.99 and 0.97; moisture – 0.92 and 1.75, respectively.

The ratio of assimilable phosphorus to total phosphorus ((P<sub>2</sub>O<sub>5</sub>assim.:P<sub>2</sub>O<sub>5</sub>total.)Ч100) reached 98.36% and 98.12%, while the ratio of water-soluble phosphorus to total phosphorus ((P<sub>2</sub>O<sub>5</sub>w.s.:P<sub>2</sub>O<sub>5</sub>total.)Ч100) amounted to 91.94% and 91.83%, respectively.

As a result of the study, the optimal operational parameters for producing phosphorus fertilizers containing monocalcium phosphate and monomagnesium phosphate through neutralization of EPA with limestone materials were established as follows:

thermal treatment temperature of limestone raw material – 800°C;

initial EPA concentration – ~17% P<sub>2</sub>O<sub>5</sub>;

EPA dosage – 100%;

neutralization duration – 60 minutes;

suspension drying temperature – 95–100°C.

Therefore, the neutralization of extraction phosphoric acid with thermally activated limestone raw material, followed by evaporation, drying, and granulation of the suspension, enables the production of highly assimilable calcium- and magnesium-phosphate fertilizers. Compared with the conventional ammophos production technology, this method completely eliminates ammonia consumption and increases the total product yield by approximately 4–5%. Furthermore, in comparison with double superphosphate manufacturing technology, the consumption of valuable phosphorite thermoconcentrate raw material can be reduced by 15–20%.

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