

# Nitric acid processing of poor apatite from the Laokai deposit.

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## Abstract

**Relevance of work.** The Socialist Republic of Vietnam is the second largest rice exporter in the world. Maintaining and increasing its production is impossible without increasing soil fertility, which is ensured by the systematic application of phosphorus-containing mineral fertilizers. The raw materials for their production are apatites from the Laokai deposit. Almost a century of operation of the mine led to the depletion of class 1 ore reserves with a high content of the target component ( $28 \div 36\% \text{P}_2\text{O}_5$ ), but the reserves of poor ore classes ( $13 \div 24\% \text{P}_2\text{O}_5$ ) are still very large and new technologies are required to ensure the country's internal food security their processing into conditioned mineral fertilizers. A feature of poor phosphate ores occurring in Vietnam is the high content of impurities in them:  $\text{SiO}_2$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{3+}$ , which impede the efficient processing of these ores by traditional methods. The solution to this problem is an urgent task, since it is aimed at developing the industrial and agricultural branches of the economy of the Vietnamese Socialist Republic through the use of local phosphate resources.

**Purpose** of work: Nitric acid processing of poor apatite from the Lao Cai deposit.

The following tasks had to be solved in order to achieve the set **goals**:

1. Determination of fractional, phase and chemical composition of a representative sample of poor ore of the Lao Cai deposit of the 2nd class and assessment of the possibility of its enrichment by primary methods.

2. Study of the influence of physicochemical factors on the kinetics of nitric acid and nitric-phosphoric acid decomposition of the sample under study and determination of the optimal parameters of the processes.

3. Determination of technological parameters of the stage of ammonization of acid extract, mixing with potassium salt, granulation and drying in the preparation of

NPK-fertilizers.

4. Determination of the physicochemical and mechanical characteristics of the obtained fertilizer samples.

5. Development of recommendations for the technical design of the process of obtaining complex fertilizers from poor Lao Cai apatite.

**Scientific novelty** of the work:

1. New experimental data on the composition, properties and characteristics of a representative sample of poor apatite of the 2nd class Lao Cai deposit were obtained.

2. The kinetics of decomposition of raw materials by strong mineral acids has been investigated and the influence of physicochemical factors has been established: temperature (in the range  $20 \div 50^\circ\text{C}$ ), concentration of  $\text{HNO}_3$  ( $0.05 \div 10\text{M}$ ), ratio L: S (1:0.01 to 3:1) and particle size (in the range of  $0.04 \div 3.0 \text{ mm}$ ) on the degree of extraction of the main component and impurities.

3. The method of effective technology for processing lean ore by nitric and nitric phosphoric acid method has been substantiated. It was found that Lao Cai apatite decomposition occurs according to a similar kinetic mechanism, the reactions proceed in the external diffusion region, the apparent values of the kinetic parameters of the processes are close:  $n = 2$ ;  $k = 0.013 \div 0.091 \text{ (mol/l)}^{-1} \cdot \text{s}^{-1}$ ;  $\gamma^{\Delta t/10} < 2$ ;  $E = 48.09 \div 48.75 \text{ kJ/mol}$ .

4. The influence of the conditions of ammonization of the nitric acid extract on the type of phosphorus compounds in the finished product was established and the technological regime was determined, excluding the loss of the target component.

5. The physicochemical properties of the obtained NPK-fertilizers were determined: concentration of the main components, moisture content, static strength of granules.

**The practical significance** of this research work:

1. The nitric acid method for producing NPK fertilizers of prolonged action was substantiated, the technological modes of individual stages of the process were determined: decomposition of Lao Cai apatite of the 2nd class, ammonization of the

obtained nitric acid extract and the introduction of potassium salt into it.

2. The consumption ratios for obtaining fertilizers with a balanced composition N: P: K = 1: 1: 1 have been calculated and practically confirmed.

3. Based on the results of the kinetic experiment, the possibility of using the modernized technological scheme for the production of NPK fertilizers for the processing of Lao Cai apatite of the 2nd class by nitric and nitric phosphoric acid methods is shown.

4. The physical and mechanical characteristics of NPK-fertilizer samples of prolonged action with a total content of nutrient components of 33 ÷ 45% were determined.