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# THE CURRENT STATUS OF RESEARCH ON THE METHODS USED TO OBTAIN MONOPOTASSIUM AND MONOCALCIUM PHOSPHATE.

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**Abstract.** The need to provide food and drinking water to the world's population is developing urgently due to the planet's rapidly expanding population and the loss of arable and irrigated land. At the start of the twenty-first century, this issue is still unsolved despite the tremendous advancements in agriculture and cattle farming. Increasing the productivity of livestock, poultry, and fish farming as well as the production of agricultural products is one of the best strategies to address this issue. The production and variety of potassium and NPK fertilizers without chlorine, as well as feed calcium phosphates, are on the rise in practically all industrialized nations worldwide.

**Keywords:** Central Kyzylkum, monocalcium, monopotasium phosphate, NPK fertilizers.

## Analysis of existing methods for the production of potassium phosphates

The main methods for producing potassium dihydrogen phosphate are the interaction of phosphoric acid with calcium-containing compounds, ion exchange and conversion methods.

When phosphoric acid reacts with salts and potassium hydroxide, the following reactions occur:

$$H_3PO_4 + K_2CO_3 = 2KH_2PO_4 + CO_2 + H_2O$$

$$H_3PO_4 + KCl = KH_2PO_4 + HCl$$

$$H_3PO_4 + KOH = KH_2PO_4 + H_2O$$

Modern production of phosphorus salts, as a rule, is based on multi-stage processes, including the production of phosphoric acid, its neutralization to the corresponding hydrogen phosphates, their isolation, drying and dehydration [59]. Commonly used are potash or potassium hydroxide and phosphoric acid. As a result, the fertilizer is expensive

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and the scale of its production is small. Even the agricultural need for fertilizers for greenhouses is not met[60].

Currently, the production of feed, food and reactive salts of phosphoric acid is based on the use of thermal phosphoric acid, obtained by electrothermal method at a temperature of 1600-1800°C [61]. These industries are energy-intensive, which, in light of the continuous rise in energy prices, leads to an increasing decrease in their profitability.

To obtain pure salts of potassium dihydrogen phosphate, thermal phosphorus, purified EPA is used or the process is carried out in an environment of organic reagents [62].

There is a known method for producing potassium dihydrogen phosphate by reacting TPA with potassium hydroxide, in which potassium hydroxide is preliminarily purified from insoluble impurities, poured into a crystallizer and, with stirring, TPA is introduced to pH 5.8-6, the solution is cooled to a temperature of 15-20°C and dihydrogen phosphate crystals are separated potassium [63].

Purification of EPA from accompanying impurities is a complex and relatively expensive method for producing acid. Purification of EPA can be carried out by evaporation and stripping with superheated steam, precipitation in the form of poorly soluble compounds, ion exchange, sorption methods, using organic solvents [64].

Therefore, the most promising methods for producing potassium dihydrogen phosphate are methods based on the use of EPA without preliminary purification.

A method has been developed for the production of potassium dihydrogen phosphate by the interaction of EPA with potassium chloride in an aqueous-alcoholic medium [65]. A method for producing potassium dihydrogen phosphate is described, including the interaction of EPA and potassium chloride in a molar ratio of 2:1 at a temperature of 70-145°C, grinding the resulting mass, extraction of excess acid with a boiling organic solvent and subsequent drying at a temperature of 80-100°C. Aminol, acetone, and N-butanol are used as organic solvents. There are methods for producing potassium dihydrogen phosphate using crude EPA [66]. The essence of the method is the neutralization of EPA with potassium carbonate (potash) at a stoichiometric rate to pH 3.5-4.5 at a temperature of 80-90°C, separation of the resulting mixture at a temperature of 70-80°C and crystallization of potassium dihydrogen phosphate from a solution at a temperature of 15 -20°C.

A method has been developed in which EPA is used together with TPA, which involves mixing 52-54% phosphoric acid with potassium chloride at a mass ratio of 2:1 and heating to 265°C [67]. The resulting mixture is dissolved in water until a saturated solution is

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obtained, water-insoluble impurities are separated by filtration and potassium dihydrogen phosphate is crystallized.

There is a known method for producing chlorine-free monopotassium phosphate, which includes neutralization of EPA with a solution of potassium carbonate to pH 3.8-4.5 at a temperature of 70-78°C, separation of the resulting mixture by filtration, subsequent crystallization and separation of the finished product upon cooling [68]. The mother liquor is returned to the potassium carbonate dissolution stage.

The ion exchange method for producing potassium dihydrogen phosphate consists of a heterogeneous reaction between a solid phase cation and a liquid phase cation exchanger in columns filled with a cation exchanger [69]. When treating a cation resin with phosphoric acid in the columns, the interaction occurs according to the following scheme:

$$H_3PO_4 + RK = RK + KH_2PO_4$$

with the formation of potassium dihydrogen phosphate. To restore the cation exchanger, a solution of potassium chloride is passed through the column according to the scheme

$$RH + KCl = RK + HCl.$$

The resulting solution is evaporated at the first stage, the potassium dihydrogen phosphate crystals are separated while cooling and dried.

This method of producing potassium dihydrogen phosphate has not found widespread use, although it is quite simple technologically due to the production of dilute solutions of potassium dihydrogen phosphate, the use of TPA and the need to dispose of hydrochloric acid solutions.

Condensation methods are based on the interaction of purified solutions of phosphoric acid salts and calcium-containing compounds, mainly potassium chloride. Ammonium phosphates are most widely used as phosphate salts, the interaction of which with potassium chloride proceeds through the following reactions:

$$NH_4H_2PO_4 + KCl \rightarrow KH_2PO_4 + NH_4Cl$$

$$(NH_4)_2HPO_4 + KCl \rightarrow K_2HPO_4 + 2NH_4Cl$$

When using sodium dihydrogen phosphate, the process is carried out according to the reaction:

$$NaH_2PO_4 + KCl \rightarrow KH_2PO_4 + NaCl$$

These reactions are reversible and depend significantly on the solubility of the salts used. The solubility of potassium dihydrogen phosphate in water is significantly lower than the solubility of ammonium and sodium dihydrogen phosphates, and when they are present

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together in saturated solutions at high temperatures upon cooling, potassium dihydrogen phosphate will precipitate first.

There is a known method for producing potassium dihydrogen phosphate, which involves the interaction of a solution of ammonium phosphate containing 16-20% $P_2O_5$, obtained by leaching ammophos from apatite concentrate, with potassium chloride at a molar ratio of $K^+$:$NH4^+$ at 95°C equal to (0.75-1):1 ) until complete dissolution, followed by filtration, cooling to 20°C and separation of crystals [70]

There is a known method for producing a complex fertilizer by the interaction of potassium chloride and solutions of ammonium phosphate at a molar ratio (1.0-1.3): 1 and a temperature of 35-85 ° C, followed by crystallization of monosubstituted potassium and ammonium phosphates at a temperature from 0 to -5 ° C [71].

There is a known method for producing complex fertilizer by reacting a solution of ammonium phosphate with a concentration of 16-20% P2O5, obtained by leaching ammophos with water at a temperature of 20-60°C and potassium chloride at a ratio of $K^+$:$NH_4^+$ = (0.75-1):1 [72]. Crystallization is carried out at a temperature of 10-20°C, the resulting precipitate is washed with a solution of ammonium phosphate with a concentration of 16-20% $P_2O_5$.

It has been established that the interaction of ammonium phosphate and potassium chloride in aqueous solutions results in the formation of mixed crystals of potassium ammonium phosphates [73]. Potassium ammonium phosphate is obtained on the basis of evaporated apatite EPA and ammophos, by leaching with water. Precipitates of potassium ammonium phosphate have high humidity, which varies from 11.5 to 25.9% and is a saturated mother solution. Since the saturated solution contains chlorine and undesirable impurities, they pass into the product during the drying process, contaminating it.

## Conclusions

From a critical analysis of literary sources it is clear that there are a large number of methods for purifying products to obtain especially pure inorganic substances. Often, the use of one or another method is limited to its selective purification from certain impurities. The most effective among the described methods, which allows deep and complete purification of various substances, both from anions and cations, is the recrystallization method. A generalization of literature data related to the production of feed and purer calcium orthophosphates from phosphate raw materials from various deposits indicates

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the need to purify the resulting solutions from accompanying impurities of phosphorites and especially from fluorine.

The production of calcium salts is based on the acid decomposition of phosphate raw materials and subsequent processing of nitric acid solutions and EPA. Methods for purifying EPA with organic solvents have become the most widespread, and precipitation purification methods are gaining momentum. Purification of EPA by sedimentation of existing impurities is safer and can be easily accomplished using existing equipment.

Mineral feed additives play a huge role in the development of livestock, poultry and fish farming. The global range of basic mineral supplements includes more than 10 items. Calcium, ammonium, and sodium phosphates are most widely used. The most valuable are calcium phosphates. In feeds where there is a significant amount of calcium and insufficient phosphorus, sodium phosphorus additives are used. To compensate for the lack of protein in the diets of cattle and sheep, non-protein nitrogen-containing compounds – ammonium phosphates – are used.

Neither potassium dihydrogen phosphate nor defluorinated monocalcium phosphate are produced in the Republic. In connection with the above, the organization of production of fertilizer chlorine-free potassium dihydrogen phosphate and feed grade monocalcium phosphate from CC phosphorites is a problem that needs to be solved.

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## Authors' Declaration

- Conflicts of Interest: None.

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours.
- No human studies are present in the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee at the Termez Institute of Engineering and Technology and Termez State University.

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