Energy efficient, no firing, air binder. Recommendations for the processing of phosphogypsum waste

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Abstract. The article presents data on the results of research and processing of phosphogypsum waste from the Samarkand Chemical Plant, over many years stored on a vast territory. Phosphogypsum contains up to 94% contains two water sulfates of calcium, which is the most valuable raw material to produce gypsum binders. However, phosphogypsum contains some chemical compounds that are harmful to human life and for this reason, it is difficult to use in industrial production without neutralization. The article presents the results of research and recommendations for solving this problem.

1. Introduction
Wall materials (bricks, stones, and blocks) account for about one-third of the total building cost of buildings and structures, including large Portland cement production, the most passionate of us all for the production or construction of durable bricks energy consumption. The main purpose of the chosen topic is to recommend and scientifically justify the use of energy-efficient materials based on modern, local raw materials, exploring the production of wall materials in terms of energy consumption.

As the solution to the main tasks of our scientific research the problem of production of gypsum-bonding agents and wall-based blocks is based on their solution.

Concentrated apatite concentrate contains phosphorous oxide P2O5 (in dry matter) up to 39%. Phosphorus extract is obtained when this raw material is treated with phosphorus and sulfate in some cases with nitric acid. In this process, the residue of phosphogypsum, which is many secondary products, is secreted. In recent years, 500 thousand tons of phosphogypsum waste more than a ton of waste is collected and waiting for recycling. The main ingredient in phosphogypsum is CaSO4 compound, which is 94% by weight [1,2]. If we analyze this material in accordance with the requirements of GOST 513-82, we can see that it is a type of gypsum. However, there are elements that prevent the use of phosphogypsum in the case of natural gypsum rock, which stops the use of this expensive product in the construction industry. It is usually a secondary product of the production of phosphogypsum, which is dissolved in powder, water-solubility does not exceed 0.2%, it is almost insoluble in water, and however, the harmful elements in the phosphogypsum are water-soluble, for example, dissolved in 0.5 to 1.5% water. Phosphorous oxide P2O5, 0.3-0.4% hydrogen phosphate ion (NPO4), and up to 1% of fluoride compounds, which must be neutralized before use. Washed in aqueous solution, it is believed that the harmful chemical elements in it are either neutralized or dissolved in lime water [3,4].

2. Proposed methodology
In order to fulfill the above objective and scientific hypothesis, the Samarkand Chemical Plant Superphosphate Fertilizer Plant was selected as a waste of phosphogypsum from the Soviet Union and occupy many areas. Even though this raw material has been stored for many years in the factory waste dumps, it is found that the elements dissolved in water-soluble, thermal treatment and milling of harmful gases - phosphorus hydrogen and phosphates.
Figure 1. The process of neutralizing harmful gases in the composition of dump phosphogypsum
In order to implement the plans, set for our research, the task was to neutralize the harmful elements in the raw material during the milling process and to convert them into neutral compounds that are insoluble in water. In the process of scientific research and the analysis of emissions of the same type of industrial production, we have encountered alkaline dry waste of the Kungrad soda plant in Karakalpakstan. This industrial waste is a secondary product of calcium soda, sodium bicarbonate (food baking soda) and caustic soda, with 93% of active lime compounds. Many scientific works of literature cite the use of this secondary product as raw material, or as an additional element in the cement industry. However, we decided to study the physicochemical properties of this element in combination with phosphogypsum in our research.

The following were the objectives of the study:

- The problem of neutralization of fluoride hydrogen and phosphorus harmful gases in phosphate gases from the Samarkand Chemical Plant in milling with the dry alkaline residues of the Kungrad Soda Plant.
- For the purpose of this experiment, the Samarkand Chemical Plant was analyzed by emissions and extracts of phosphogypsum from various layers of long-term storage. In particular, a certain number of samples were extracted from the Kungrad Soda Plant’s dry alkaline waste range. The chemical composition of these components was studied and presented in tables in the form of oxides.
- Methods of scientific research. The pre-planned internationally recognized method of neutralizing harmful gases in phosphogypsum has been adopted. Detection and detection of hazardous amounts of fluoride hydrogen gas are followed by a 15% solution of calcium and glycerin containing 3% carbon dioxide as figure 1, [5,6]

3. Experiments, results

The experiments were conducted in a closed building in the department of grinding and mills of Regional Research Laboratory-5 of SSCI. The aim was to observe the changes in the laboratory microclimate and samples when the phosphogypsum was pulled in a mill when the harmful fluoride hydrogen or phosphorus hydrogen gas was removed, and the phosphorous substance was mixed in a mill with a dry alkaline component.

The method of determining the amount of hydrogen phosphorus in the air or in the body is based on the determination of the concentration of gas by phosphoric acid as a result of oxidation of potassium permanence solution. Studies were performed at the lab site, during the drying of the items, in the milling process, and at half-time intervals of samples (table 1).

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| Components, % | Place of analysis and sampling period | Phosphorous-Hydrogen (PH$_3$) - the result of analysis from two parallel layers, mg / m$^3$ | Fluoride Hydrogen (HF) - the result of analysis from two parallel layers, mg / m$^3$ |
|---------------|--------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| First layer test, 100 | At the time of loading in the mill | 0.01 | 0.056 |
| 30 min after grinding in a mill | 0.09 | 0.09 |
| 60 min after grinding in a mill | 0.093 | 0.097 |
| At the moment of emptying the mill | 0.28 | 0.135 |
| Layer Test | Test Value | Time of Loading | 30 min after grinding | 60 min after grinding | At the Moment of Emptying |
|------------|------------|----------------|-----------------------|----------------------|--------------------------|
| Second Layer test, 100 | 0 | 0.01 | 0.103 | 0.098 | 0.13 |
| | | | | | |
| Third Layer test, 100 | 0 | 0.10 | 0.103 | 0.118 | 0.132 |
| | | | | | |
| Third Layer test, 95 | 5 | 0.10 | 0.05 | 0.017 | 0.009 |
| | | | | | |
| Third Layer test, 90 | 10 | 0.01 | 0.003 | 0.001 | 0.00 |
| | | | | | |
| Third Layer test, 95 | 15 | 0.01 | 0.00 | 0.00 | 0.00 |

Note:
- fluoride hydrogen (HF) - maximum permissible concentration of atmospheric air (PDC) - 0.05 mg / m³;
- Phosphorus hydrogen (PH₃) - maximum permissible concentration of gas in atmospheric air (PDC) - 0.1 mg / m³.

4. Discussions
According to our experimental prohibitions, a small amount of fluoride hydrogen and phosphorus hydrogen gases were detected in the samples from various layers of phosphogypsum, which have been
stored for many years at the Samarkand Chemical Plant. In the deep layers of storage, there is practically no change in content, the maximum permissible concentration of harmful gases is more than 2 times. The main studies were carried out in 3 layers (depth up to 2 meters). It was observed that during the drying process, with the addition of 5% dry alkaline additives to the phosphogypsum, the number of harmful gases had a permissible concentration limit, and the gases were neutralized when the mixture was milled. It was found that no increase in harmful gases was observed in lab air and mill dust when the number of dry alkaline additives increased by 15%. Based on the repeated experiments, it is recommended to use the dry alkaline additives at the Kungrad Soda Plant with 10-15% in the process of thermal treatment of phosphogypsum and milling.

5. References
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