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Phosphogypsum Carbide Recovery

Saydullayev A.A.
Tashkent State Medical University Chirchik branch, Tashkent, Uzbekistan

Hamrokulov J.B.
Tashkent State Medical University Chirchik branch, Tashkent, Uzbekistan

Saydullayev S.A.
Tashkent State Medical University Chirchik branch, Tashkent, Uzbekistan

Corresponding author email: temirov-2012@mail.ru

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Annotation: As the world population increases, the demand for food products is increasing. Land use is important to meet these needs. The fertility of currently used soils is decreasing year by year. This work presents the results of studying the process of obtaining phosphogypsum urea based on phosphogypsum and urea liquefaction. The strength of fertilizer granules obtained by adding phosphogypsum to urea liquefaction in the studied proportions increased from 2.61 to 4.25 MPa, and the pH of the granules decreased from 8.02 to 7.92. The tests showed that the N content in the composition was from 43.97 to 45.94%, the CaO content from 0.09 to 0.87%, and the S content from 0.16 to 1.54%. The resulting fertilizer samples have a significant impact on improving the agrochemical and agrophysical properties of soils and increasing plant productivity.

Keywords: Urea, phosphogypsum, phosphogypsum urea, fertilizer, soil, density, viscosity, nitrogen, sulfur.

INTRODUCTION

Currently, urea is successfully used as a nitrogen fertilizer throughout the world. Urea is a fertilizer with a high nitrogen content, which is necessary for the growth and development of plants. **[1]** According to data, the world production of urea is more than 200 million tons, and in Uzbekistan it is produced more than 650 thousand tons per year.

In industry, urea is synthesized from liquid ammonia and gaseous carbon dioxide at a temperature of 458-468 K and a pressure of 19-20 MPa. In the process of urea synthesis, a solution consisting of water, urea, carbamate, ammonium carbonates and ammonia is formed. Then the solution is distilled to thermally decompose the carbamates and carbonates and remove ammonia and carbon dioxide that are not converted to urea, and the resulting aqueous urea is processed into a solid product by granulation. During the granulation and evaporation of urea at high temperature, one molecule of ammonia is released from two molecules of urea, resulting in the formation of biuret. An increased biuret content in fertilizer inhibits seed germination, plant growth and development. Therefore, according to [2], the biuret content in the finished product is allowed to be no more than 0.6% (maximum) in grade A and 1.4% in grade B.

Biuret formation is observed to varying degrees at all stages of the process. Favorable conditions for the formation of biuret are: removal of ammonia from the reaction sphere; high temperature; prolonged exposure of concentrated urea solutions to high temperatures. The greatest effect on increasing urea formation and reducing biuret formation is the introduction of an excess of ammonia in the initial mixture relative to the stoichiometric amount determined by the molar ratio $NH_3 : CO_2 = 2$. Excess ammonia reduces the harmful effects of water released in the process, and it binds water, thereby changing the reaction of urea to ammonium carbamide. Therefore, urea synthesis is carried out in excess ammonia, the resulting product also contains free ammonia, the resulting product is not immediately packaged in bags, urea is stored in a warehouse for a certain time before packaging to remove free ammonia. It should be noted that in all currently available urea production technologies, the final solution in the form of liquid urea still contains a small percentage of ammonia, which increases in the final concentration stage, as a result of which 1 mol of biuret and 1 mol of ammonia are formed from 2 mol of urea. At the end of the granulation stage, the resulting product contains a certain amount of free ammonia, which passes into the cooling air and, as a result, is released into the atmosphere, polluting it [3-6].

In the work [7], it was found that the introduction of the full calculated dose of phosphogypsum (10 t/ha) resulted in a 50% decrease in soil alkalinity, an increase in calcium content, and an increase in water resistance. Under the influence of phosphogypsum, a significant improvement in the physical properties of the soil was also noted: porosity, the composition of water-resistant aggregates, and density. An average increase in the yield of agricultural crops by 46% was ensured, including 54% for winter wheat and 31% for fodder beet.

Uzbekistan has large reserves of phosphogypsum, which are increasing. More than 100 million tons of phosphogypsum have accumulated in waste and are one of the causes of air pollution. The processes of obtaining granular urea with phosphogypsum based on urea liquefaction and phosphogypsum were studied. As a result, a fertilizer with an N content of 43.97 to 45.94%, a CaO content of 0.09 to 0.87%, and a S content of 0.16 to 1.54% was obtained. In addition, with an increase in the amount of phosphogypsum, the strength of the product granules increased as follows: $(NH_2)_2CO$: phosphogypsum . 100 : 0.5 - 2.61 MPa; 100 : 2.5 - 3.54 MPa; 100 : 4 - 3.91 MPa; 100 : 5 - 4.25 MPa. With an increase in the amount of added phosphogypsum, the pH of the obtained fertilizers decreased from 8.02 to 7.92. In the processing of phosphogypsum-containing urea solutions into granular fertilizers, their rheological properties play an important role. In particular, the density and viscosity of the solutions were studied at the above weight ratios $(NH_2)_2CO$: phosphogypsum at a temperature of 130-145°C. The results showed that with an increase in the mass ratio of phosphogypsum to urea liquefaction at a temperature of 135°C to 100 : (0.5– 5), the density and viscosity of the solutions increased from 1.16 to 1.31 g/cm^3, leading to an increase from 2.56 to 3.67 cPz came. A similar situation was observed at other temperatures. In the studied proportions, in the temperature range of 130 - 145°C, all samples of urea - phosphogypsum solutions have a sufficient fluidity, which creates favorable conditions for their granulation without difficulties. It is known that the lower the water solubility of urea granules, the slower the release of nitrogen from the fertilizer in the soil, which indicates its long-term effect on the plant. Thus, if the complete dissolution of $(NH_2)_2CO$ granules takes an average of 92.4 seconds, then the introduction of phosphogypsum in powder form in an amount of 0.5 to 5 g per 100 g of urea reduced the dissolution rate of the product granules from 92.4 to 149.8 sec. One of the indicators affecting the quality of urea is the porosity of its granules. The porosity of pure $(NH_2)_2CO$ granules was 5.75%. Adding phosphogypsum to the $(NH_2)_2CO$ slurry led to a decrease in porosity. Thus, when the mass ratio of $(NH_2)_2CO$: phosphogypsum was changed from 100:0.5 to 100:5, the porosity of urea granules decreased from 5.75 to 3.75%.

Studies on the production of granular phosphogypsum urea based on phosphogypsum and urea liquefaction have shown the possibility of obtaining phosphogypsum urea with sufficient granule strength. Phosphogypsum urea granules have a weaker solubility than pure urea, that is, they release nutrients more slowly, reducing the rate of dissolution of fertilizer granules, reducing nitrogen losses in the soil, phosphogypsum in urea increases its agrochemical efficiency, which helps to significantly improve the agrochemical and agrophysical properties of the soil and increase its fertility.

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