ENRICHED SUPERPHOSPHATE BASED ON PHOSPHORIC ACID GYPSUM PULP AND CARBONATE PHOSPHORITE FLOUR

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Abstract: *to obtain enriched superphosphate, it is proposed not a mixture of sulfuric and phosphoric acids, but phosphoric acid gypsum pulp (PAGP), which is formed during sulfuric acid extraction and thermal concentrate in the dihydrate mode. To PAGP, having L : S = 2: 1, 2.5: 1, 3: 1", phosphate flour (PF) is dosed with weight ratios PAGP : PF from 100: 15 to 100: 40, that is condition of non-stiffening pulp. For all brands of PAGP, the optimal ratio of PAGP : PF is 100: 25, which yields samples of enriched superphosphate with a high content of total and digestible forms of P_2O_5, with a value of $P_2O_{5\ wat.} : P_2O_{5\ total.}$ not less than 50%.*
Keywords: *phosphoric acid gypsum pulp, phosphorite flour, interaction, enriched superphosphate, composition.*

ОБОГАЩЕННЫЙ СУПЕРФОСФАТ НА ОСНОВЕ ФОСФОРНОКИСЛОТНОЙ ГИПСОВОЙ ПУЛЬПЫ И КАРБОНАТНОЙ ФОСФОРИТОВОЙ МУКИ

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Аннотация: *для получения обогащенного суперфосфата предлагается не смесь серной и фосфорной кислот, а фосфорнокислотная гипсовая пульпа (ФКГП), образующаяся при сернокислотной экстракциии термоконцентрата в дигидратном режиме. К ФКГП, имеющей Ж : Т = 2 : 1, 2,5 : 1, 3 : 1, дозируется фосмука (ФМ) при весовых соотношениях ФКГП : ФМ от 100 : 15 до 100 : 40, то есть обеспечивающих условие незагустевающей пульпы. Для всех марок ФКГП оптимальным соотношением ФКГП : ФМ является 100 : 25, при котором получаются образцы обогащенного суперфосфата с высоким содержанием общей и усвояемой форм P_2O_5, со значением $P_2O_{5водн.} : P_2O_{5общ.}$ не менее 50%.*
Ключевые слова: *фосфорнокислотная гипсовая пульпа, фосфоритовая мука, взаимодействие, обогащенный суперфосфат, состав.*

In addition to simple and enriched superphosphates, single phosphate fertilizers include calcium dimonophosphate (33-36% P_2O_5), obtained by activating low-grade phosphate raw materials with lowered phosphoric acid [1, 2], precipitate (44% $P_2O_{5\ ass.}$, TU 113-08-513- 82) and double superphosphate (43-49% $P_2O_{5\ ass.}$, GOST 16306-80). The latter is a concentrated fertilizer [3]. But to obtain it, we need high-quality phosphate raw materials and concentrated H_3PO_4.

Simple superphosphate produces by sulfuric acid decomposition of natural phosphates, and enriched with a mixture of sulfuric and phosphoric acids by chamber, chamber stream methods. For the production of enriched superphosphate, it is possible to use phosphate raw materials with a content of 20% P_2O_5 and more. Given the low concentration of P_2O_5 (17-18%) and a high content of CO_2 (15-20%) in Kyzylkum phosphorites, it is rational to conduct a study on obtaining enriched superphosphate by decomposing phosphoric acid gypsum pulp (PAGP) of JSC Ammofos-Maxam (Uzbekistan), obtained in the dihydrate mode of decomposition of washed calcined concentrate (26% P_2O_5) with 93% sulfuric acid [4]. PAGP is a suspension consisting of $CaSO_4 \cdot 2H_2O$ in

an aqueous solution of phosphoric acid. It is used for the production of supraphos-NS, the essence of which process consists in carrying out the reaction of its deep ammonization (to pH = 8.5):

$CaSO_4 + H_3PO_4 + 2NH_3 = CaHPO_4 + (NH_4)_2SO_4$

We use the phosphate raw material to neutralize PAGP instead of NH_3, which allows to obtain a single phosphate fertilizer such as enriched superphosphate. The process is studied in the real production PAGP three brands (wt.%): 1) with L : S = 2: 1 - $P_2O_{5\ tot.}$ 12.19; $P_2O_{5\ wat.}$ 12.04; $CaO_{\ total.}$ 12.47; $SO_{3\ total}$ 16.61; pH = 0.59; 2) with L : S = 2.5: 1 - $P_2O_{5\ tot.}$ 13.13; $P_2O_{5\ wat.}$ 13.08, $CaO_{\ total.}$ 10.07; $SO_{3\ total}$ 14.55; pH = 0.28; 3) with L : S = 3: 1 - $P_2O_{5\ total.}$ 14.33; $P_2O_{5wat.}$ 13.56; $CaO_{\ total}$ 8.75; $SO_{3\ total}$ 13.65; pH = 0.20; and as phosphate raw materials served as phosphate flour (PM) Kyzylkum (wt.%): 17.76 P_2O_5; $P_2O_{5\ ass}$ on citric acid: $P_2O_{5\ total.}$ = 17.74; 47.51 CaO; 1.79 MgO; 0.73 Fe_2O_3; 0.95 Al_2O_3; 3.27 SO_3; 17.02 CO_2; 5.27 insoluble residue; $CaO_{\ total}$: $P_2O_{5\ total}$ = 2.68.

The experiments were carried out in a reactor with a volume of 200 ml, where the calculated amount of PAGP was loaded, and then with stirring, FM was gradually dosed to it at a weight ratio of PAGP: PM from 100: 15 to 100: 40. The components were reacted at 70°C for 60 minutes. Next, the superphosphate mass was discharged from the reactor, was ripened at 95-100°C. After cooling, the obtained product was crushed and analyzed for the content of various forms of P_2O_5 according to known methods [5].

The results show that the increase in the mass fraction of PM in relation to the PAGP, although it does not greatly affect the total content of P_2O_5 in the product, but significantly reduces the relative content of digestible and aqueous forms of P_2O_5. So, with the ratio "L : S = 2: 1" with an increase in the weight ratio PAGP : PM from 100: 15 to 100: 40 in products, the content of $P_2O_{5\ total}$ is in the range of 22.52-22.75%, and the degree of transformation $P_2O_{5\ ass}$: $P_2O_{5\ total}$ decreases from 91.25 to 73.22% and $P_2O_{5\ wat}$: P_2O_5 total from 83.56 to 17.41%. With L : S = 2.5: 1, these figures vary within 24.21-25.6%, from 92.46 to 74.06%, from 89.14 to 65.55% and from 86.44 to 22.22%, with L : S = 3: 1 they are 26.3-28.81%, from 93.09 to 75.39%, from 89.31 to 67.11% and from 86.84 to 28.59%. This shows that the greater the ratio L : S, the more concentrated the P_2O_5 is fertilizer.

Most importantly, in all products there is no free H_3PO_4 with the exception of the ratio PAGP: PM = 100: 15 (0.72-1.21% $P_2O_{5\ free}$). Depending on the L : S and PAGP : PM moisture phosphate pulps is within 32.24-42.53%. At the same time, the pulp does not set at stops, is easily involved in the granulation process, does not show abnormal phenomena during drying, does not fix the quantitative selection of fluoride compounds.

At the request of agriculture, single phosphate fertilizer should have $P_2O_{5\ wat.}$: $P_2O_{5\ total}$ not less than 50%. On this basis, for the ratio L : S = 2: 1, the optimal ratio PAGP : PM is 100: 25, and for 2.5: 1 and 3: 1 - 100: 30. At the same time, for the first brand, an enriched superphosphate of composition (wt.%) is obtained: $P_2O_{5\ total}$ 22.66; $P_2O_{5\ ass.}$: $P_2O_{5\ total}$ = 84.82; $P_2O_{5\ wat.}$: $P_2O_{5\ total}$ = 59.13; for L : S = 2.5: 1 - $P_2O_{5\ total}$ 24.7; $P_2O_{5\ ass.}$: $P_2O_{5\ total}$ = 82.06; $P_2O_{5\ wat.}$: $P_2O_{5\ total}$ = 49.15; for L : S = 3: 1 - $P_2O_{5\ total}$ 27.21; $P_2O_{5\ ass.}$: $P_2O_{5\ total}$ = 82.87; $P_2O_{5\ wat.}$: $P_2O_{5\ total}$ = 52.74. What is important is the fact that calcium in them is in digestible form.

Thus, the conducted research creates prerequisites for the development of single phosphate fertilizer technology by using PAGP and poor PM and produces granular enriched superphosphate in-line using existing equipment of supraphos production at "Ammofos-Maxam" JSC.

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