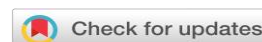




Research Article



Study of the Process of Evaporation of Saturated Solutions in Obtaining Potassium Nitrate

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Annotation

The presented thesis analyzes the state of world production of potassium nitrate with the substantiation of the relevance of the problem being solved and the study of the influence of technological parameters on the process of evaporation of mother solutions of potassium nitrate by the conversion method. The influence of formed during technological processes on the degree of output of K_2O and not less in products is studied. Optimal technological parameters for obtaining potassium nitrate by conversion method from potassium chloride and ammonium nitrate have been established.

Keywords: potassium chloride, conversion, potassium nitrate, ammonium chloride.



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The production of chlorine-free water-soluble complex fertilizers is a promising and intensively developing segment of mineral fertilizer production, as evidenced by the following figures: the capacity for the production of potassium nitrate in the world amounted to over 474 thousand tons/year. The growth rate of the global market for chlorine-free water-soluble fertilizers is estimated at 4% per year.

We have improved the process of obtaining potassium nitrate by conversion methods.

First, an analysis of multicomponent systems K^+ , $NH_4^+ // Cl^-$, $NO_3^- - H_2O$ was carried out, which are the theoretical basis for choosing the range of variation of process parameters and the sequence of process processes.

In this work, based on the analysis of the solubility diagram of K^+ , NH_4^+ , $//Cl^-$, $NO_3^- - H_2O$, the following range of variation of the main process parameters was selected: $KCl:NH_4NO_3 - 1,0-1,2:1$; conversion duration - 1-40 min, crystallization temperature - 5-20 oC, crystallization duration - 15-30 min.

The influence of the $\text{KCl}:\text{NH}_4\text{NO}_3$ ratio, temperature and duration of conversion, as well as the kinetics of crystallization at temperatures of 5, 10 and 20 °C were studied.

As the obtained data show, in the studied intervals after the conversion process, regardless of the conversion conditions at 90 °C, no solid phase is formed in the system.

After a specified duration of the conversion process, the system was cooled to a certain crystallization temperature with stirring at a stirrer speed of 50-100 rpm and cooling at 2-14 °C*/min.

The resulting solid product and liquid phase were analyzed for the content of K^+ , Cl^- and nitrogen in the form of nitrate and ammonium using a generally known method in the field of mineral fertilizers.

The following optimal process parameters were established: $\text{KCl}:\text{NH}_4\text{NO}_3$ ratio = 1:1 ÷ 1,1:1, conversion duration - 2-3 min, conversion process temperature 95-100 °C, crystallization temperature and duration 5-10 °C and 30-40 min, respectively. It was determined that with a change in the above parameters, the potassium nitrate yield fluctuates from 46,44 to 54,53%, and L:S - in the range of 3,75-4,70, the filtration rate is 1066.24-2213.85 kg/m²h.

The process of evaporation of the mother liquor formed during conversion was studied depending on the input process parameters and it was established that with 30-40% evaporation, the yield of ammonium chloride is 3,15-16% of the total mass of the mother liquor.

Below is a thermogram of the ammonium chloride obtained under optimal conditions.

Thermoanalytical studies of the presented samples were carried out on a Netzsch Simultaneous Analyzer STA 409 PG (Germany) with a K-type thermocouple (LowRGSilver) and aluminum crucibles.

All measurements were carried out in an inert nitrogen atmosphere with a nitrogen flow rate of 50 ml/min.

The temperature range of measurements was 25-370 °C, the heating rate was 5K/min. The amount of sample for one measurement was 5-10 mg. The measuring system was calibrated with a standard set of substances KNO_3 , In, Bi, Sn, Zn.

In the temperature range of 20-170 °C, three endothermic peaks were observed without changing the mass of the sample.

The first two (86,7 and 149,7 °C) most likely characterize phase transitions - the first peak $T_{\text{max}} = 86,7\text{oC}$ and $\Delta Q = -5,23\text{J/g}$ and $T_{\text{max}} = 149,7\text{ °C}$ and $\Delta Q = -2,57\text{ J/g}$ (first-order phase transitions - transition from a metastable crystalline state to a stable one) and the third peak $T_{\text{max}} = 185,9\text{ °C}$ and $\Delta Q = -27,24\text{ J/g}$ can be caused by melting of the sample.

The destruction (decomposition) process begins after 227,7 °C. Destruction occurs at a rate of 7% per min. Decomposition of the sample occurs with a mass loss of 90% up to 310 °C.

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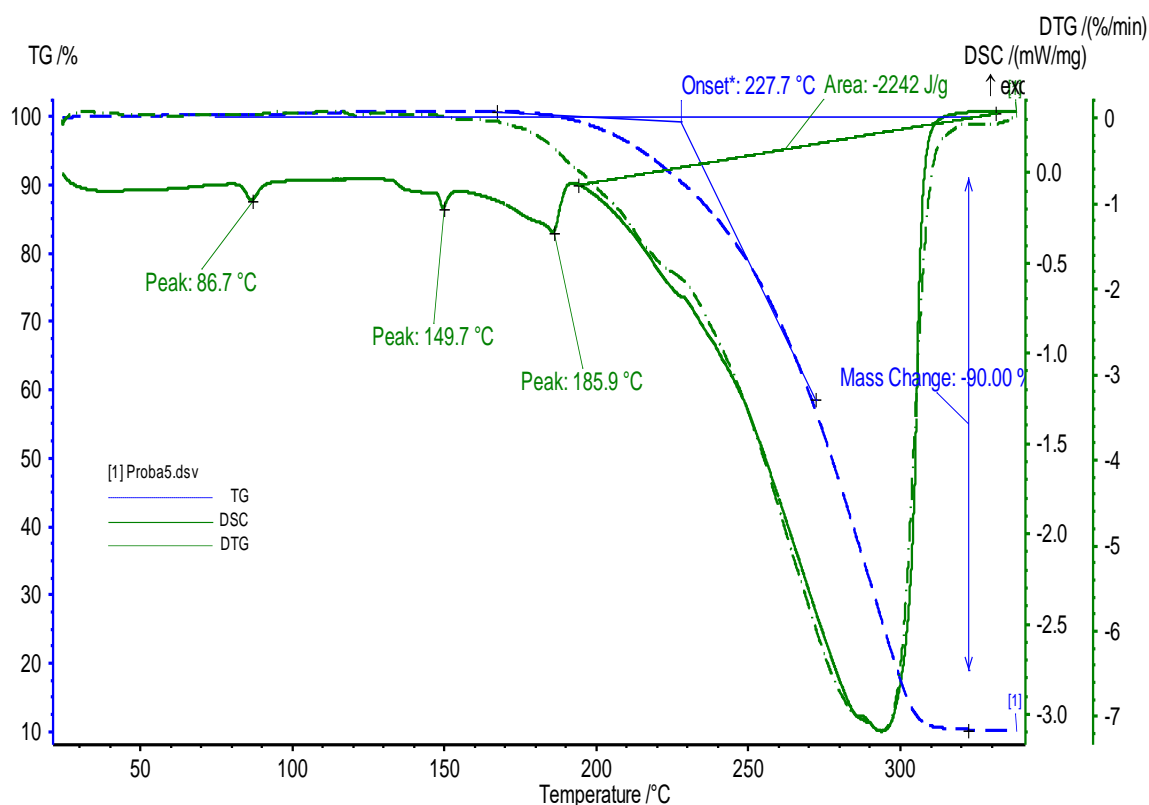


Fig. TG-DSC curve of ammonium chloride formed during evaporation of the mother liquor.

The process of destruction (decomposition) begins after 227,7 °C. Destruction occurs at a rate of 7% per minute. Decomposition of the sample occurs with a mass loss of 90% up to 310 °C.

Thus, the obtained data show that the conversion method can be used for a short conversion time to obtain sufficiently pure ammonium chloride with good technological indicators of the conversion processes.

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