Technological calculation of granulation equipment for the production of ammonium nitrate with a nanoporous structure: algorithm and software implementation

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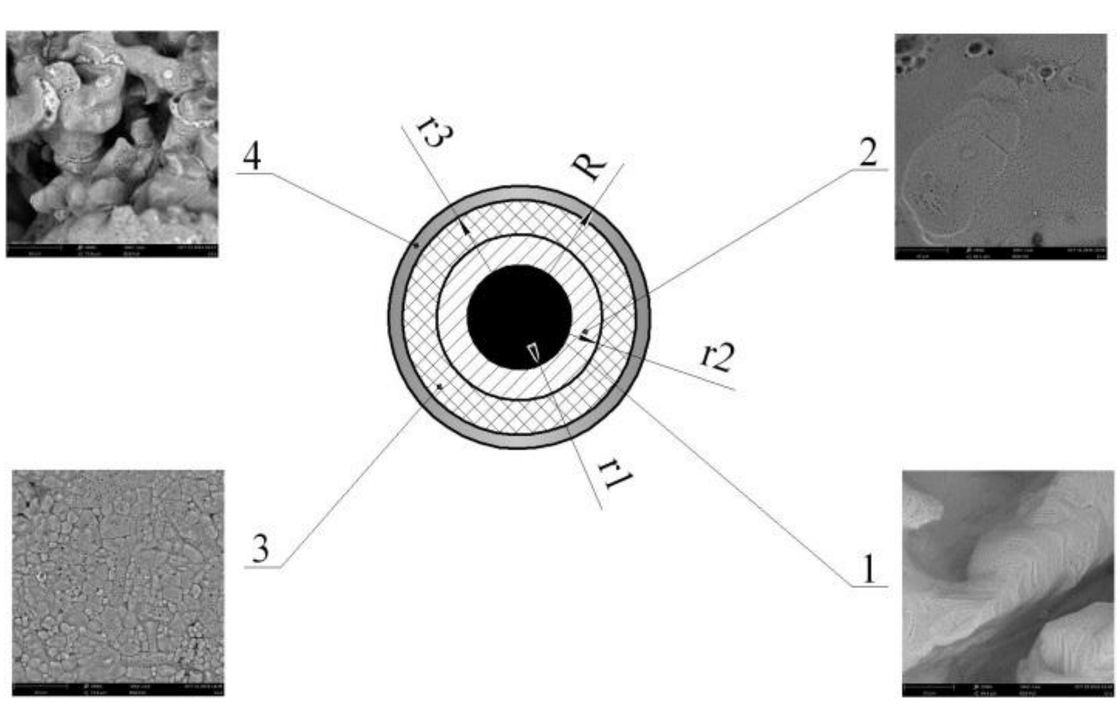
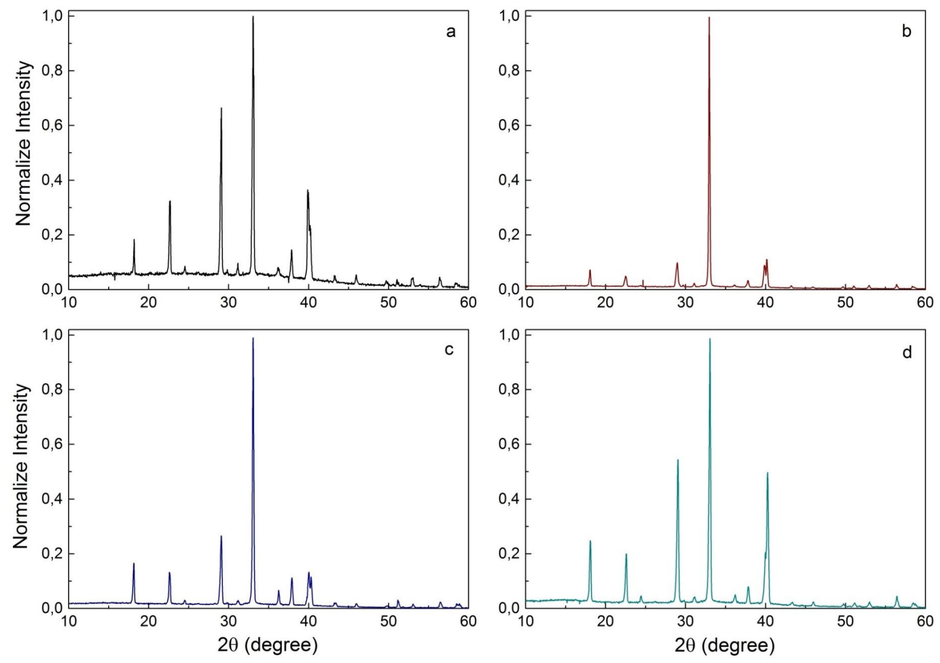
Abstract – this work is devoted to searching for the optimal design of granulation equipment for the modification of ordinary ammonium nitrate with the subsequent obtaining of a nanoporous structure. The fundamentals of technological calculation of vortex-type granulation equipment with various configurations of a vortex fluidized bed (including a combined one) are presented. An algorithm for searching for the optimal design of a vortex granulator, which can provide a developed nanoporous structure of ammonium nitrate granules and their specific properties, is presented. The need for an optimization calculation of granulation equipment using computer modeling has been substantiated. Computer modeling and automated calculation in the general method of engineering calculation of granulation equipment are shown. The results of electron microscopy of porous ammonium nitrate samples are presented and the features of the pore structure (size, configuration, specific porous volume, etc.) are analyzed.

Keywords **-** 3D Nanostructured Porous layer, Vortex granulator, Moisturizing



Structure of the porous ammonium nitrate granule: 1 – core; 2 – inner layers; 3 – central layers; 4 – outer layers (surface); R – radius of the granule; r – current radius of the granule



Diffractograms from the ammonium nitrate granules: a – an initial granule; b – granule after humidification with water and thermal treatment; c – granule after humidification with urea solution and thermal treatment; d– granule after humidification with ammonium nitrate solution and thermal treatment

The influence of humidifier type on granules quality

Type of humidifier	Strength, kg / granule	Absorption capacity, %	Holding capacity, %
Water	**0,4**	**8,3**	**9,6**
Solution of ammonium nitrate	**0,4**	**8,4**	**10,1**
Solution of ammonium nitrate and carbamide	**0,4**	**8,5**	**11**
Solution of ammonium nitrate, carbamide and lauryl sulfate sodium	**0,42**	**8,5**	**11,4**

Conclusions

Analysis of experiments results has shown, that various types of humidifiers can form various kinds of pores after drying according to the classification:

- cracks, chips, cavities - "mechanical" pores;
- channels of various shapes - "modification" pores (micro, meso- and macro-ores).

Some of these pores were formed as a result of thermal stresses and inadequate core strength of initial granule («mechanical» pores), some – directly into granules during the drying process after humidification («modification» pores). Various types of humidifiers also have significant effect on the ratio of values of «mechanical» and «modification» pores.

The obtained results allow to select the optimal humidifier composition, which promotes the formation of significant amount of macropores on surface and mesopores of near-surface areas.