Selection of optimal technological parameters for obtaining encapsulated organic-mineral fertilizers with nanoporous structure

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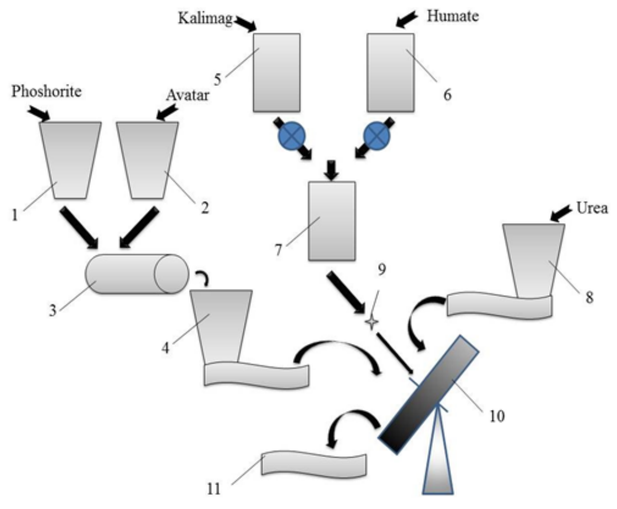
Abstract – The creation of organic-mineral fertilizers with a developed porous structure requires a systematic approach to determining the optimal technological parameters for implementing the process. In addition, it is necessary to carry out an optimization calculation of the design of the main apparatus as part of the technological scheme - a disc granulator. An important subject of study is the investigation of the effect of the composition of the organic shell and the binder on the characteristics of nanopores.

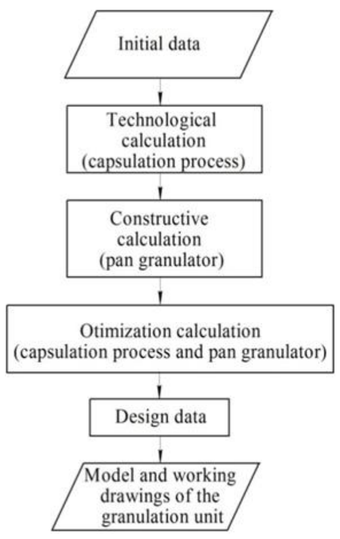
Keywords – Organic-Mineral Fertilizers 3D Nanostructured Porous layer, Disc Granulator

Model installation for encapsulating fertilizers



1 - phosphorite bunker; 2 - microelements bunker; 3 - mixer; 4 - dispenser; 5 – potassium-magnesium solution tank; 6 - humate solution tank; 7 – potassium-magnesium and humate mixing tank; 8 - urea granule feed unit; 9 - nozzle; 10 - disc granulator; 11 - tray for granulated product

Pan Granulator software



Initial data

Q_{dr} - dry product productivity of the pan granulator, kg/h;

k_1 - batch moisture, mass fraction;

$R_{s.a}$ - flow rate of the seeding agent, kg/h;
$R_{s.a}$ is taken in the range from 0,2 Q_{dr} to Q_{dr}

t_{pr} - process temperature, °C;

A, B – constants which are depending on the type of granulated material;

φ_m - angle of repose of the granulated material, degr;

α - pan tilt angle, degr; condition of granulator's functioning: $\varphi_m < \alpha$;

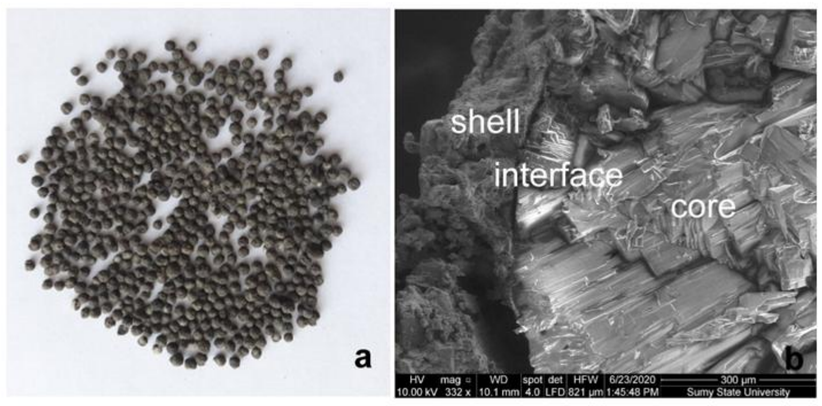
ε - pan filling degree, m^3/m^3;

k_3 - coefficient of refinement of the pan revolutions working number; $k_3 = 0,6\text{-}0,9$.

γ_{gr} - bulk density of granulate, N/m^3.

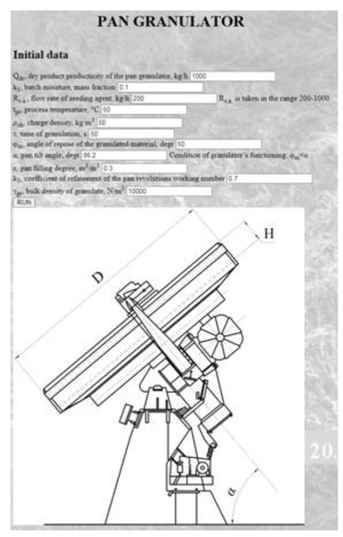
Algorithm for calculating the pan granulator and granulation unit

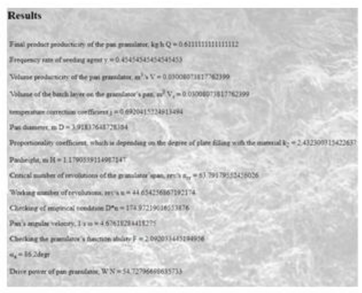
Sample of organic-mineral fertilizer



General view of encapsulated organo-mineral fertilizer (a) and microscopy of a preproduction model of the encapsulated fertilizer (b)

Pan Granulator software





Initial data and design of pan granulator

Conclusions

1. Analysis of IP documents and literature data made it possible to highlight the shortcomings of existing organic-mineral fertilizers and propose a new composition of encapsulated fertilizer with a high content of micro- and macroelements.
2. A description of a new method of obtaining organic-mineral fertilizers is given, and its advantages are shown.
3. It is proposed to obtain organic-mineral fertilizers of a new composition in a pan (disc) granulator, taking into account the presented advantages of this method of implementing the encapsulation technology.
4. The block-scheme of the algorithm for calculating the pan granulator, as well as the theoretical block for determining its construction dimensions, are presented.
5. The data of quality indicators of the obtained organic-mineral fertilizer is given.
6. The proposed technology of capsulated fertilizer formation allows to get uniform nanoporous structure on the surface and in depth of the shell.
7. Improving the physicochemical properties of the encapsulated granule is reached by achieving a homogeneous transition layer in the contact zone of the shell and the granule core.
8. The network of deep sinuous nanopores allows the penetration of soil moisture into the granule and sequentially dissolve first the organic part of the shell, and then the nitrogen core of the encapsulated granule.
9. The granules are without mechanical defects, the shell is tightly attached to the core. Such granules can be transported to the soil fertilizer site without loss of strength properties.
10. Due to the presence in the batch of a small number of granules with a nonuniform shell the further improvement of the proposed in this article technology for the production of organic-mineral fertilizers is required.