ENVIRONMENTAL ASPECTS IMPLEMENTATION OF HIGH-GRANULATION EQUIPMENT FOR THE PRODUCTION OF NITROGEN FERTILIZERS

ЭКОЛОГИЧЕСКИЕ АСПЕКТЫ ВНЕДРЕНИЯ ВЫСОКОЭ ФЕКТИВНОГО ГРАНУ ЯЦИОННОГО ОБОРУДОВАНИЯ ПРИ ПРОИЗВОДСТВЕ АЗОТНЫХ МИНЕРАЛЬНЫХ УДОБРЕНИЙ

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The main advantages of using the rotating oscillating granulator (prilling method) and vortex pellet (method in fluidized bed granulation) in the production of mineral fertilizers. Constructive solutions for the modernization of these devices in order to obtain higher product quality and reduce dust emissions. On the basis of comparison of qualitative products is justified by replacing the previously used pellet on the design of the equipment. The test results also showed a decrease in the concentration of dust in the exhaust gases of the apparatus compared with existing analogues equipment.

Приведены ос овные преимущества использования вращающихся вибрационных грануляторов (метод приллирования) и в хревых грануляторов (метод гранулирования во взвешенном слое) в производстве м неральных удобрений. Предложены конструктивные решения для модернизации этих аппаратов с целью полу ения продукта более высокого ачества и уменьшения выбросов пыли в а мосферу. На основании данных сравнения ачественных по азателей продукции доказана целесообразность замены ранее используемых грануляторов на конструкцию рассматриваемого оборудования. Р зульта *испыт ний также показали с ижение концентрации пыли в отходящих из этих аппаратов газах по сравнению с существующими аналогами оборудования.*

Ключевые слова: *гранулирование, вращающийся вибрационный гранулятор, вихревой гранулятор, качество, экология.*

Keyword *granulation, rotating oscillating granulator, vortex granulator, quality and ecology.*

1. Statement of the problem.

Economic activity of people making significant changes in the environment, which is gradually approaching the global natural phenomena. However, humanity, which is part of the biosphere of the planet, it is necessary to form such concepts of economic growth, which would combine the development of industrial potential with a focus on the preservation of its natural environment and the economy of its resources. One of the solutions to the problems of environmental protection and resource conservation is the development and introduction of low-waste and waste-free process, the local waste treatment, the use of current resources to ensure their re-use, recovery of valuable components from the waste to a commercial product or secondary raw materials, improving the efficiency of equipment [1].

This is fully applies to the chemical industry, in particular for the production of nitrogen fertilizer. Getting the fat of these fertilizers, is characterized by two main methods of the process of granules: prilling and granulation in fluidized bed [2].

One of the most significant components of loss of nitrogen during the production of fertilizers is the emission of dust fertilizer cooling air into the atmosphere [2,4]. For example, the unit of production of ammonium nitrate AC - 60, with an airflow through the tower of about 300 m^3/hour and a dust content of nitrate 200-250 mg/m^3 annually emits more than 1500 tons of nitrogen fertilizer. Thus, the dust content of ammonium nitrate, which is in the air in the cavity tower, can reach 0.8 g/m^3. [4] This leads to product loss and requires additional cost for cleaning exhaust air from the tower.

In addition to the economic aspects related to energy and resource consumption, and the problem is environmental - air pollution, fertilizers getting into surface and ground water, the accumulation of nitrite and nitrate in plants and reservoirs, leading to pressure on the ecosystem.

The purpose of article - justification of opportunities to improve the environmental efficiency of production of nitrogen fertilizers using modernized equipment for prilling and granulation in fluidized bed.

Research objects - rotating oscillating granulator melt (ROG) and vortex pellet weighted layer (VPWL).

2. Prilling using ROG

In world practice, for granular nitrogen fertilizer most widely used method of prilling. This method or process for producing a tower nitrogen fertilizer characterized by dispersion melt of ammonium nitrate or urea droplet diameter 4mm in the granulation tower, followed by cooling and crystallization of solid granules in a free fall in the upstream flow of cold air. The process is carried out in cylindrical or rectangular towers. At the top of the tower is set from 1 to 8 granulator (dispersant) of the melt which are conical basket cylindrical, spherical or radial shape, the working surface of which (side or bottom) has several thousand openings of different or equal diameters. On the ceiling of the tower set 1-6 fans that sucked air out of it. Depending on the construction of the tower in the air, the internal volume of the coolant is supply directly to "fluidized bed" and a window that is located at the bottom around the perimeter of the tower, or the airflows directly through these windows and the volume of the tower rises to the extractor fan. The lower part of the tower - the bottom is perform in the form of truncated cones, which is between the annular gap (slit) for air suction and cleaning of the tower cones of nitrogen fertilizer granules. The overall flow of air that is blown through the tower, the 250 - 700 thousand m^3 [2-4].

Analysis of the sources of loss product in the preparation of nitrogen fertilizers tower method [2] has allowed to define existing problems and to develop more efficient hardware design of the granulation process to reduce damage, including environmental.

The most rational direction of solving this problem for the existing production of nitrogen fertilizers tower method is to develop a host melt dispersion, which would provide the possibility of obtaining mono disperse granules of urea or ammonium nitrate with a minimal amount of fines (granules). Currently operated granulators (dispersants) in the other manufacturers (copying the design developed in Sumy State University in the last century) allows to obtain a product with the following characteristics of particle size distributions: mass fraction of granules less 1.0 mm - 0.5-1.5%, mass fraction of granules 2.0 -4.0 mm - 90-98%, with a mass fraction of granules 2.0 -2.5 mm - 42-71%, and the granules of 2,0 -3.0 mm - 85-95% [2]. Dispersion of the melt to give 2% dust-forming particles having a size less than 1.0 mm and more 3.5mm. Which can also be destroy, forming dust leads to the presence of nitrogen fertilizer dust in the air in the cavity tower.

On the basis, this took a number of research works on modernization of the famous rotating vibrating nitrogen fertilizers pellet melts [5]. In the course of their execution was carried out refinement of mathematical models of the melt for this type of pellet with the influence of the design features of its internal devices on the hydrodynamics of the fluid, the main patterns of design decisions imposing disturbances and consider the possibility of managing the collapse of the jet with the help of external disturbances.

The research led to the development of a modified design of the rotary vibration pellet melts nitrogen fertilizer, which was pilot-scale tests on the unit of production of ammonium nitrate AC - 60 PSC "Concern Stirol" (Ukraine). Variable parameters: speed granulator, the frequency of vibration, the load on the float of ammonium nitrate, hydrodynamic parameters of melt movement within the basket and conditions of the expiry of the jets from the holes. Parameters were determined: particle size distribution of the product and the content of ammonium nitrate in the exhaust air from the tower. Particle size distribution of ammonium nitrate and the strength of the granules were determined in accordance with regulations.

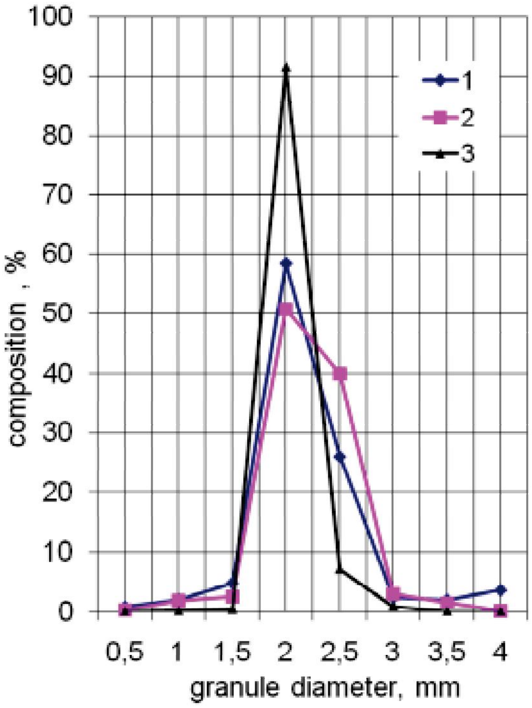

Fig. 1. Fractional composition of granules of ammonium nitrate: 1 - modified pellet of ROG without the imposition of vibration, 2 - operated granulators ROG of other manufacturers, 3 - modified pellet ROG, construction of Sumy State University.

Size distribution of the product produced by the acoustic design of pellet of Research Institute of Chemical Engineering [2], modified and operated by ROG, is shown in Figure 1.

The modified rotary vibrating granulator ROG products from the following particle size distribution: mass fraction of granules less 1.0 mm - 0.02-0.2%, mass fraction of granules 2.0 -4.0 mm - 96,0-99,9%, the mass fraction of granules 2.0 -2.5 mm is not less than 88%. Furthermore, when the vibration frequency provided granulator to obtain a product with the main fraction of granules 2,5 -3.0 mm more than 65%, while increasing the strength of the granules of the main fraction.

Modifications of rotary vibratory pellet melts nitrogen fertilizers has improved the mono disparity of the resulting product and reduce its content in the dust-forming particles of less than 1.0 mm and more than 4.0 mm. Comparative data on the content of the mass fraction of granules less than 1.0 mm a product which is withdrawn from the tower during operation pellet different designs, are shown in Figure 2. [2]

Comparative data on the content of the mass fraction of granules more than 4.0 mm in the finished product, which is withdrawn, from the tower during operation pellet of different designs, are shown in Figure 3 [2].

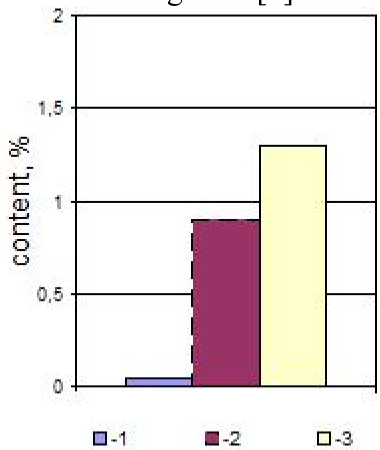

Fig. 2. Mass fraction of granules less than 1.0 mm in the finished product: 1 - modified pellet of ROG; 2 - operated granulators of ROG; 3 - static design of Research Institute of Chemical Engineering granulator.

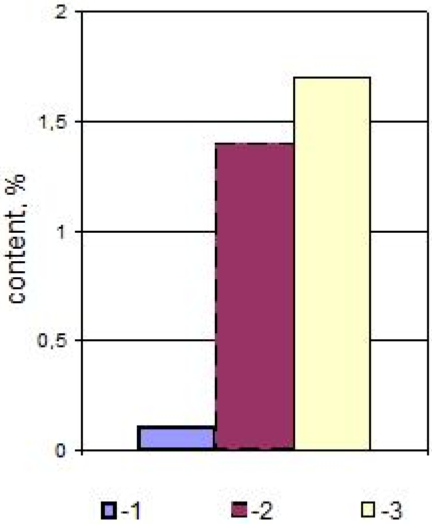

Fig. 3. Mass fraction of granules more 4.0 mm in the finished product: 1 - modified pellet of ROG 2 - operated granulators of ROG 3 - static design of Research Institute of Chemical Engineering granulator [2].

Reducing the mass fraction of particles in the dust-producing products helped to reduce the dust content of ammonium nitrate in the air, i.e. discharged from the tower. When testing a modified rotary vibration granulator of ROG figure was on axial flow fans from 22 to 34 mg/m^3, with average values of 22 to 28 mg/m^3. Override vibration granulator system led to increased average fertilizer dust content in the air exiting the tower to 35 mg/m^3.

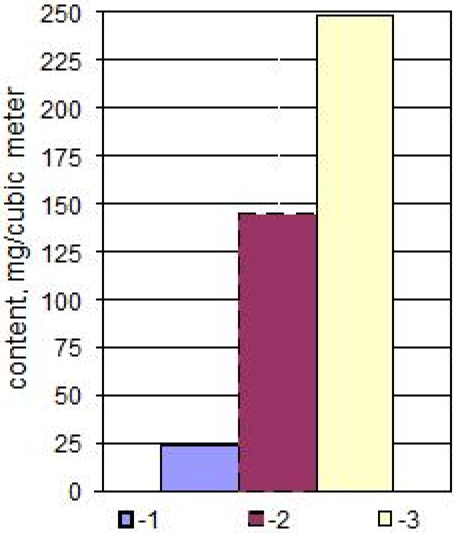

Fig. 4. Average for axial flow fans dust content of ammonium nitrate in the exhaust air from the tower: 1 - modified pellet of ROG construction of Sumy State University, 2 - operated granulators ROG other manufacturers, 3 - static design of Research Institute of Chemical Engineering granulator.

Comparative data for ammonium nitrate content of dust in the air that is discharged from the tower during operation pellet of different designs are shown in Figure 4. [2]

Similar results were obtained in the production of urea “Nevinnomysskiy Azot” in testing of some design decisions made later in modified pellet of ROG. With commercial operation of the equipment for a month consistently received the following particle size distribution of the product: the mass fraction of urea granule size of less than 1.0 mm - 0.1-0.3%, the mass fraction of urea granule size of 1.0-4.0 mm - 99,7-99,9%, mass fraction of urea granule size of 2.0 -4.0 mm - 96,5-98,9%, the mass fraction of granules more than 4.0 mm - Was absent.

The presented results of commercial operation of equipment in the production of urea and pilot testing of a modified pellet of ROG in the production of ammonium nitrate showed the effectiveness of the design, made famous granulator changes and have reduced the economic and environmental damage in the production of nitrogen fertilizers.

3. Pelletizing in VPWL.

Using a fluidized bed granulating processes for nitrogen fertilizers developed to create a contact surface with the granulated product gas stream and increase the specific power equipment. Along with these advantages, the use of fluidized bed does not solve the problem required in industrial environments motion control pellets in the working space of the granulator. This may lead to loss of product quality and consumer increasing dust emissions. The residence time of the particles in the granulator must ensure the full completion of crystallization and cooling. Exceeding residence time required to destroys granules and a sharp increase in the fine fraction carried off from the apparatus.

Significant carryover of fines from fluidized bed apparatus is also due to the fact that, once after the spray droplet is covered by the rising flow of fluidizing agent. Thus, droplets leave displacement granulator mirror, before reaching the fluidized layer.

The use of a vortex-weighted layer allows the development of control mechanisms pellet in flight and control the time of her stay in the machine. In conjunction with the selection of the correct configuration workspace granulator, balanced application of the vortex layer allows the classification of granules into fractions. Involvement drops into rotational motion helps to reduce the uplink component gas stream. This further reduces the likelihood of entrainment of fine fraction of the pellet mill, increasing the eco-efficiency of its operation.

Several theoretical and experimental studies of the hydrodynamic conditions of the formation of a vortex weighted layer of granules [6] as the basis for developing an algorithm, calculating the hydrodynamic vortex granulator [7].

Studies have shown that the vortex granulator with variable section workspace [8-10] characterized by the following advantages:

- The possibility of fast changeover depending on the feedstock properties and requirements for the final product;
- A wide range of possible configurations of the weighted layer (fluidized, spouted, swirl or a combination thereof) depending on the design of the gas distributors.

Analysis of the fluid bed granulator [11] allowed us to offer effective methods to reduce the dust content in flue gases:

- The use of devices with variable cross-section of the working space;
- Multi-touch pellets with the gas stream and then returning it to the workspace granulator for growing;
- The possibility of organizing the internal circulation retur;
- Selection of the optimal conditions of the gas swirling flow.

These methods should provide control over the time of pellets in the machine that provides the required particle size distribution of the finished product and its strength properties.

As the design methods to reduce dust concentration in the exhaust gas from the granulator is also proposed [12], the use of separation devices.

Comparative analysis of the size distribution of the product with the existing fluidized bed granulator and small eddy different apparatus of embodiment [13] (Figure 5 and 6) showed that has a greater degree of mono disparsity product obtained using vortex granulator.

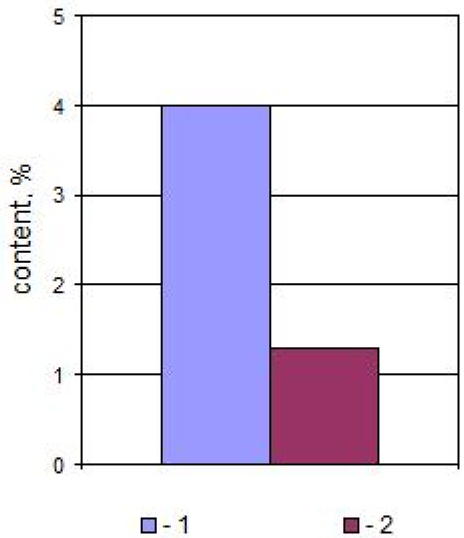

Fig. 5. Mass fraction of granules more 3.0 mm in the final product: 1 - fluidized bed granulator, 2 - vortex granulator.

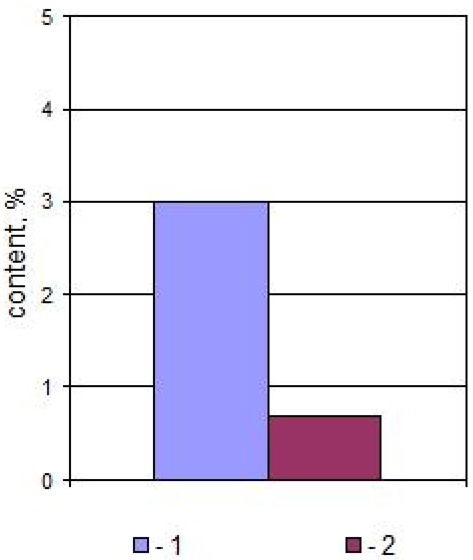

Fig. 6. Mass fraction of granules less 1.0 mm in the final product: 1 - fluidized bed granulator, 2 - vortex granulator.

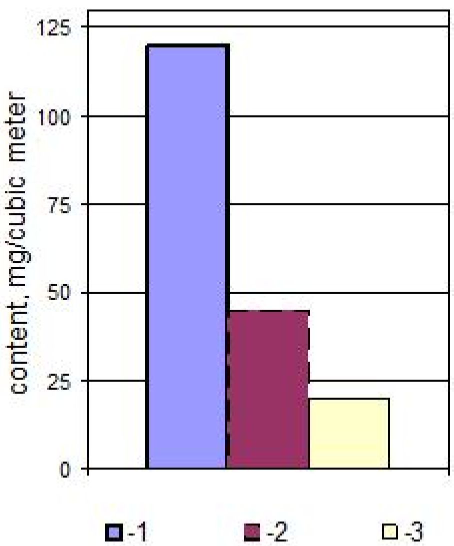

Fig. 7. The average dust concentration of ammonium nitrate in the exhaust air from the granulator: 1 - fluidized bed granulator, 2 - Vortex granulator, 3 - granulator vortex separation section

Analysis of the gas at the outlet of the vortex granulator (Figure 7) showed the advantage of this type of apparatus to the fluidized bed granulators. Additional installation of separation devices greatly reduces the dust content in flue gases.

Conclusions.

1. Offered experimentally tested in an industrial environment design high-performance equipment for granulation method prilling and granulation in fluidized bed.

2. The comparison of the quality of the granular product with analogues.

3. The basic directions of reducing dust in the exhaust gases and environmental efficiency of the granulation equipment.

Выводы.

1. Предложены конструкции высокоэффективного грануляционного оборудования для гранулирования методом приллирования и во взвешенном слое.

2. Приведено сравнение качества полученного гранулированного продукта с аналогами.

3. Показаны основные направления уменьшения содержания пыли в отходящих газах и экологическая эффективность предложенного грануляционного оборудования.

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