

Drying and Granulation of Organic Substances in the Apparatus with Active Flow Hydrodynamics

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Abstract – Authors of the article have proved the necessity and prospects of using fertilizers on an organic basis. It is proposed to use recycled materials (organic suspensions) as a feedstock for obtaining granulated fertilizers. A method of organic suspension granulation in a fluidized bed apparatus has been thoroughly studied and presented in the article.

Key words – granulation, fluidized bed apparatus, organic suspension.

I. Introduction

Currently production and rational use of fertilizers is an extremely important task for the agriculture of our country. Agricultural sector of Ukraine's economy (agriculture, food and processing industry) ensures food sovereignty and it provides up to 17% of GDP and about 60% of the population consumption fund.

However, over the past decade, there takes place catastrophic destruction of farmland and reduction of soil fertility in Ukraine. Intensity of soil destruction and degradation is due to the use of outdated agricultural technologies and because of neglecting basic rules of farming [1].

It should be also noted that most part of the produced agricultural products does not meet international standards of quality and safety, which reduces export potential of the country and causes high morbidity rate. As a result, it contributes to the decline of rural areas.

At the same time it is necessary to mention that organic production is rapidly spreading all over European countries and in the world. There is developing an integrated system of management and production of food and other products. This system, first of all, takes into account preservation of the environment, and its biodiversity, conservation of natural resources, application of high standards and methods of fertilizer manufacturing.

Organic farming aims to improve population health by means of the high-quality food production, soil fertility and environment maintaining, rural development and promotion of local and regional production [2, 3].

The EU has developed and is currently introducing an Action Plan to implement and enlarge manufacturing of organic products, most EU member states have their own national programs for the development of this way of farming.

Experts estimate that global market consumption of organic products is approximately € 40 billion. And it tends to grow further.

In view of the above, and taking into account that Ukraine is focused on cooperation with Europe and on European way of development, there is an urgent need to develop and implement the production of fertilizers, specially adapted for the cultivation of environmentally friendly products for internal and external markets.

II. Experimental

Use of organic waste as feedstock is relevant, because it solves both the problem of organic fertilizer production and the problem of organic waste disposal. However, the effectiveness of fluidization technology application in the fertilizer production for obtaining fertilizers with intended properties is determined by the temperature regime, granulation and heat transfer peculiarities in a fluidized bed. The solution of these tasks faces difficulties due to lack of experimental and theoretical studies on this issue.

There is known a method of producing granular fertilizers on an organic basis [4], which is based on dewatering of liquid systems in a fluidized bed. If one maintains air temperature within 70-80°C, two processes simultaneously occur in the layer – granules build-up (enlargement) and the formation of a small amount of fine particles. The results obtained under the laboratory conditions (Fig. 1) prove that dynamic system equilibrium takes place in the working parameters of the process.

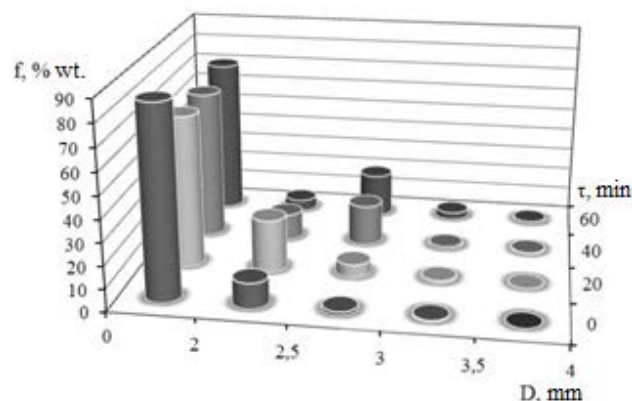


Fig. 1. Histograms of particle size distribution at different moments of time during granulation process with substance consumption 25 ml/min

This temperature regime is the operating mode for the preparation of organic fertilizers and it provides constant operation of the apparatus for a long time with continuous producing of granules of marketable size. As a result one obtains multi-layered granules of given particle size distribution, having very high density and strength (Fig. 2).

The disadvantage of this granulation method is the return of fine fractions back into the fluidized bed. As a result of different residence time of coarse and fine particles the granule surface coating with the substance is uneven. The result product is non-uniform as to its particle size distribution, which worsens the quality.

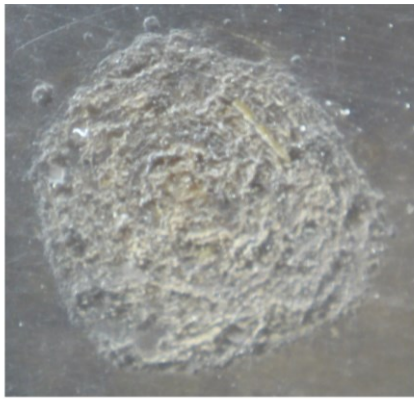


Fig. 2. Organic granules cuts (chicken manure)

To eliminate the mentioned disadvantages it is proposed to conduct granulation in a shelf fluidized bed apparatus with a spray nozzle (Fig. 3) [5].

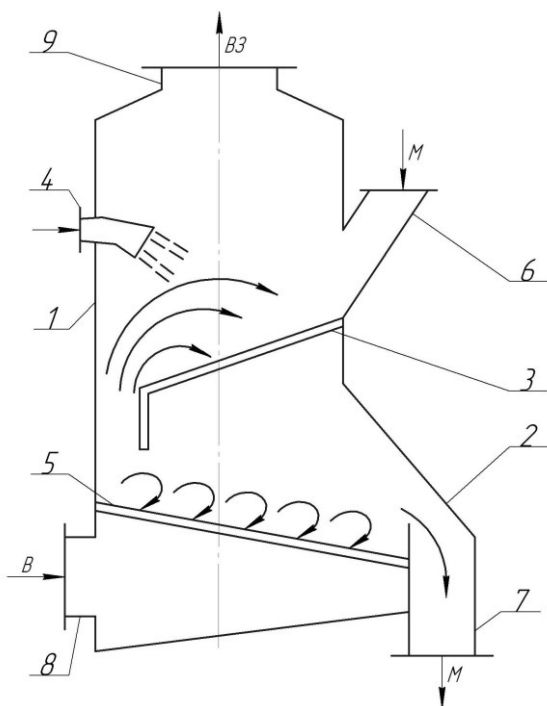


Fig. 3. Shelf granulator: 1 – separation section; 2 – drying section; 3 – perforated shelf; 4 – air nozzle; 5 – air distributor plate; 6 – nozzle for primer introduction; 7 – nozzle for ready granules withdrawal; 8 – nozzle for drying agent introduction; 9 – nozzle for the worked out agent withdrawal.

Principle of shelf device operation is the following. Gas flow is introduced into the space between the perforated shelf 3 and a separation device wall. Thus there is formed a whirling bed in the separation zone, whereon a slurry is sprayed by means of a nozzle 4.

Gas flow accelerates particle speed and in the fluidized bed there takes place separation process and particle size distribution: larger particles fall into the bed near the edge of the gas distribution grid 5 and the smaller ones-on the first section of the grid. As a result, the time when particles of different size stay in the volume of a fluidized bed in the shelf 3 is aligned.

It provides even covering of the granules with suspension, as well as increasing monodispersity of the product particle size distribution.

From the granulation section 1 finished granules are sent to the drying section 2, where there takes place their drying in the fluidization mode.

Harmonious combination of these processes provides the continuous operation of the apparatus and unit as a whole. And the resulting multi-layer single-component product (Fig. 4) has increased strength and density.



Fig. 4. General view of marketable granules

Conclusion

The proposed technology for producing organic-based granules in a fluidized bed apparatus enables to increase the obtained fertilizers efficiency and to minimize quantitative incorporation of fertilizers into the soil, and so it provides much less environmental pollution.

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