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Technology for producing granulated fertilizers enriched with microbiological components, including the determination of individual process parameters and technical and technological aspects.

Keywords; *fertilizers, microbiological components, microorganism, biobased product*

Abstract

The work presents process calculations, technological and equipment assumptions for the technology of producing microbiologically enriched granulated mineral fertilizers.

The use of bio-based products containing microorganisms that support plant growth is an established reality in agricultural crops. The high quality of the offered products, containing elite strains, allows limiting and preventing the use of mineral fertilization, contributing to cheap and sustainable agriculture [1-4)]. Research has now directed its efforts towards finding new products that further improve the performance of those already available on the market and new formulations or inoculation strategies that contribute to greater productivity and effectiveness of these products. Microbiological support for plant cultivation is a rapidly growing segment of the agricultural market, especially as a complement to traditional fertilization [5-8)]. A desirable application method is the addition of microorganisms to agricultural products in order to facilitate their application and ensure appropriate dosing. Known solutions for producing biofertilizers require the use of aqueous solutions, which in the final stage of the production process require drying the fertilizer at elevated temperatures or require the use of devices for pressure compacting the product. Since both moisture and high pressure strongly reduce the survival of microorganisms, both in living and spore form, the use of these processes significantly reduces the microbiological activity of microbiologically enriched fertilizers. Moreover, the use of water or aqueous solutions and suspensions affects the activation of bacterial spores, which then die during storage of the fertilizer. Eliminating the use of water in the production process and using low-melting substances ensures very high survival of microorganisms in the biofertilizer production process and significantly extends the durability of the finished product.

As part of the Biofertil project, a technology for producing microbiologically enriched mineral fertilizers was developed [9-10)].

Technological part

The following fertilizers were used for granulation: Polifoska Si and Super Fosdar 40.

The fertilizer was heated by a stream of hot air in a rotating granulation drum until the fertilizer temperature reached approximately 70-80^{o}C. Then, powdered polyethylene glycol PEG 4000 was added, which melted in contact with the hot fertilizer, covering the fertilizer with a thin film. Then, a mixture of bacteria consisting of a consortium of freeze-dried bacterial strains of Bacillus sp. Wheat 4/4, Paenibacillus polymyxa CHT114AB, Bacillus amyloliquefaciens AF75BB was dosed, which stuck to the fertilizer granules. Glycerin was added at the end of the process, which facilitated the binding of the rest of the bacteria and reduced dust formation. The obtained product was cooled.

Based on research on a ¼ technical scale, assumptions for the technological part of the process design were developed. The main operations, i.e. heating of the granulate, its coating and cooling after coating, and unit operations are carried out in batches.

The installation includes: a hoist with a traverse on a running beam for transporting a big bag with granules to the granulate heater, an granulate heater, a station for weighing portions of binder and biocomponent, an binder and biocomponent mixer unit with a mixture tank and a weighing dispenser, adjustable feeder of the mixture to the coating drum, coating drum, cooling drum of granules after coating, air cooling unit with chilled water unit, transport system of cooled granulate to the screen, vibrating screen sieves, power supply, control, supervision and support system operation of the installation with the control cabinet and operator panels.

Conclusions:

1. The production of biofertilizers by coating mineral fertilizer granules with an external layer containing an inert carrier seems to be the most appropriate direction for the production of this type of products.
2. The use of PEG 4000 as a binder and carrier of freeze-dried bacteria allows for even application of the freeze-dried substance.
3. During the production process, it is advantageous to use low temperatures and avoid as much water consumption as possible, because in the presence of moisture, especially at elevated temperatures, as during drying, rapid growth of live bacteria from their spore forms occurred.
4. It is also beneficial to physically separate the bacteria from the fertilizer granules so that they are not exposed to high local concentrations of mineral salts formed when the fertilizer is dissolved in the soil under the influence of moisture. Differentiating the dissolution rate of both layers by creating an easily soluble outer coating containing microorganisms may have a positive impact on the efficiency of using biofertilizers.
5. The produced microbiologically enriched fertilizers were characterized by high crushing resistance above 60 N/granule.
6. The share of granules with a diameter between 2.5-3 mm was over 90% for the microbiologically enriched Polifoska Si and 3-4 mm, respectively, over 90% for the microbiologically enriched Super Fosdar 40.
7. The fertilizers produced did not show any tendency to caking.
8. The minimum number of microorganisms in manufactured fertilizers should not be less than 1.0 x 106 units/g of fertilizer.

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