Granulation and drying of fertilizers based on alternative source of phosphorus

Mateusz Przywara[1], Michał Kołodziej[1], Wojciech K. Marek[1], Maksymilian Olbrycht[1], Maciej Balawejder[2].

1. Department of Chemical and Process Engineering, Faculty of Chemistry, Rzeszow University of Technology, POLAND, Powstańców Warszawy Ave. 6, 35-959 Rzeszów
2. Chair of Chemistry and Food Toxicology, University of Rzeszow, POLAND, Rejtana Ave. 16c, 35-959 Rzeszów

Abstract – The effect of process variables on granulation of fertilizers was studied. Computer simulations of the granulation process were performed. A comparison of application of pan granulator and fluidized bed granulator was presented. The kinetics of granule drying was also determined.

Keywords – granulation, drying, fertilizers, process simulation.

1. Investigation of the granulation of fertilizers

The amount of organic waste from meat production is growing in the world. The growing amount of bone remains has been recognized as one of the significant environmental challenges. Some of this waste can be reused as fertilizers [1-3].

The properties of powders are of critical where the design and operation of industrial equipment, as well as avoiding problems such as arcing in silos, segregation in solids and other problems that often result in process stoppage or low-quality products [4]. Granulation is one of the methods of improving the fluidity of powders and is done by creating intermolecular bonds between primary particles [1].

Granulation tests were carried out using a laboratory pan granulator and a fluidized bed granulator (Figures 1-3). The materials used for laboratory tests were powdered mixtures of various salts used as components of fertilizers, as well as powdered organic materials and burnt bones. The size of the particles of powdered feed was under 150 μm. Water and aqueous solutions with different additives were used as binding liquid.

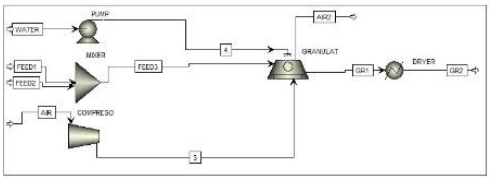

Fig. 1. Granulation process diagram

Fig. 2. Laboratory pan granulator

Fig. 3. Fluidized bed granulator

The aim of the laboratory tests was the selection of the granulation parameters. The influence of the moisture content and encapsulation on the size of granules was investigated using both granulation methods. A mathematical model of the granulation process was developed to support the process design.

The moisture content of the granules as well as encapsulation have significant effect on the granule size distribution (GSD). Figure 4A shows GSD for the fertilizer granulated with the encapsulation, and Figure 4B without the encapsulation. In the former case much smaller granules were obtained. There is no significant difference in GSD obtained with the pan granulator and the fluidized bed granulator (Fig. 5). However, the fluidized granulation requires more binding liquid, and the obtained granules had more irregular shape.

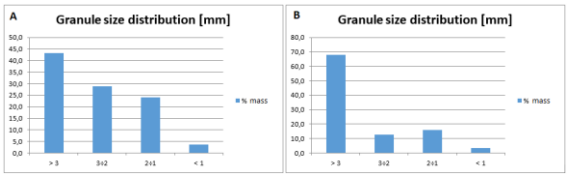

Fig. 4. GSD – pan granulator for: A) with encapsulation; b) without encapsulation

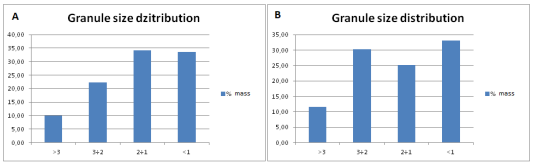

Fig. 5. Granule size distribution for: A) pan granulator; B) fluidized bed granulator

2. Investigation of the kinetics of granule drying

The drying kinetics is presented in the form of a drying rate curve. From the obtained data the kinetic time of drying was calculated, which determines the longitudinal dimension of the dryer.

The kinetics of drying for granules with different dimensions of all granulated fertilizers were investigated. The studies performed revealed that practically for all tested granules drying occurs in the second drying period (Fig.6). The total drying times were calculated and compared to the experimental ones. The results obtained were producible, the calculated drying times were in agreement with experimental ones; a relative error between the simulations and the experiments was equal to 1.8-3.6%.

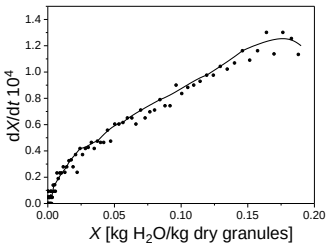

Fig. 6. Representative kinetic curve of drying.

Conclusion

1. The granulation parameters has been selected correctly. Computer simulations of granulation were in agreement with the experimental results.
2. Determination of the drying kinetics of granules of the fertilizers enabled the selection of a dryer type and its engineering design.

Acknowledgments

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