



# MME SEE

## CONGRESS 2023

5<sup>th</sup> Metallurgical & Materials Engineering  
Congress of South-East Europe  
Trebinje, Bosnia and Herzegovina  
7-10<sup>th</sup> June 2023

# CONGRESS PROCEEDINGS

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PROCEEDINGS**

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The Faculty of Technology at the University of Banja Luka, Bosnia and Herzegovina;

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## THE ADVANTAGES OF USING PELLETIZED GYPSUM COMPARED TO POWDERED GYPSUM

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Powdered gypsum products were the standard for agricultural gypsum for many years, but as growers look to maximize their return on investment, they are increasingly turning toward pelletized gypsum – a premium alternative. Pelletized gypsum offers several significant advantages over other forms of gypsum such as powdered or ultra-fine gypsum, these advantages will be discussed in the paper. This has led to increased grower adoption and a greater demand for fertilizer and soil amendment producers to offer gypsum in a pelletized form. Producers are also finding that they stand to gain a few benefits from offering a pelletized product as well.

**Keywords:** gypsum, pelletized gypsum, powdered gypsum.

### Introduction

Pulverized gypsum (Fig.1.) is a powdered form of gypsum that may be derived from a variety of sources, both natural and synthetic. It may be mined and crushed into a powder, or it may be in the form of dust or fines resulting as a byproduct from another mining or processing operation. As such, powdered and pulverized gypsum products are available in a variety of grades.

Pelletized gypsum can be derived from the same sources, but is upgraded in particle size by the pelletizing or wet granulation process – a form of agitation agglomeration [1]. The granules produced in this process are round and generally fall between 2-5 mm in size (4 x 10 mesh) (Fig.2.).

Depending on the specific product parameters desired (bulk density, particle size distribution, etc.), various types of equipment are available for pelletizing gypsum, including: pin mixers, rotary agglomerators, pugmill mixers, disc pelletizers, and a combination thereof [2]. The most common approach employed for soil amendments and fertilizers is the pin mixer-disc pelletizer combination, as this produces a highly refined granular product and allows for improved size control.

### *Benefits of Pelletized Gypsum*

Growers have long recognized the benefits of applying gypsum – a source of essential sulfur and calcium, a natural aerator, and much more – to their soils.



**Figure 1** Pulverized gypsum



**Figure 2** Pelletized gypsum

The appeal of powdered gypsum over lump gypsum is, in addition to its traditional use, that it is available to consumers at a lower cost. It is also considered “fast-acting,” meaning that the product goes to work almost immediately, courtesy of its fine particle size and subsequent high surface area to volume (SA:V) ratio. But a variety of factors can stand in the way of realizing gypsum’s full benefits when it is applied as fines. By pelletizing gypsum, producers can help the growers to fully realize gypsum’s benefits, while also maximizing their return on investment.

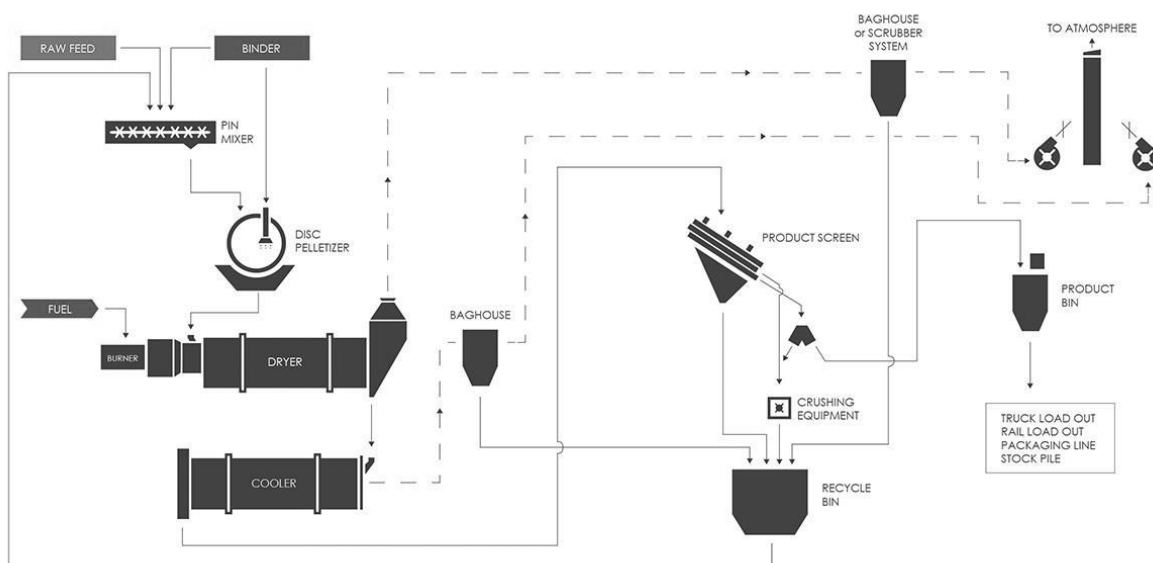
Pelletizing can be carried out using various types and combinations of equipment. Perhaps the two most common devices used are the disc pelletizer (also known as a pan granulator) and rotary drum [3] (Fig.3.). The disc pelletizer consists of a rotating disc mounted onto a stationary base. Material and binder are continuously fed onto the disc; the tumbling action, combined with the tackiness created by the binder, causes fines to gather together and refine into pellets as they continue moving around the disc. The rotary drum works on similar principle, but granules are tumbled in a rotating drum instead [4].



**Figure 3** 3D Models of a Disc Pelletizer (left) and Rotary Drum Agglomerator (right)

And while pelletized gypsum incurs a higher cost, due to the additional processing that goes into producing the product, it has a few advantages that make it worth the extra investment – for both the grower and the producer.

A typical flow diagram utilizing this approach is illustrated in Fig. 4. below.



**Figure 4** Simplified Pelletizing Process Flow Diagram [5]

### ***Benefits to Growers***

Growers are able to take full advantage of their gypsum application when using a pelletized product. This is because pelletized gypsum is not dusty, offering several benefits that contribute to its performance and effectiveness:

#### ***Reduced Product Loss***

A dusty product is difficult to handle and apply; material is frequently lost in the process. Further, applying powdered gypsum to fields often results in a portion of the product becoming windblown, causing the farmer to lose some of the investment before it even hits the ground [5].

#### ***More Predictable Results***

A dusty product also makes results less predictable, causing product to be unintentionally deposited in surrounding areas, and leaving the farmer to guess how much of the application actually stayed on the field.

#### ***Improved Flowability = Easier Handling & Application***

Pelletized gypsum is almost entirely dust-free, allowing growers to apply gypsum with ease and achieve accurate application results. Pelletized gypsum is also significantly more flowable than powdered gypsum, preventing clogging and caking issues. Additionally, pelletized gypsum does not require special spreading equipment.

#### ***Uncompromised Delivery Rate***

While it's true that the smaller the particle size, the faster the active ingredient delivery, this should not deter growers from selecting a pelletized product over a powdered one.

Pellets produced via agitation agglomeration are manufactured to hold up to the rigors of handling and transportation, while still breaking down for fast delivery upon application (in the presence of sufficient moisture). All of these benefits give growers a greater opportunity to increase their yields and maximize their investment [3].

### ***Benefits to Producers***

In addition to satisfied customers, producers can also gain some advantages by offering a pelletized product.

#### ***More Diverse Product***

The pelletizing process is inherently flexible, allowing producers to incorporate beneficial additives into their process to enhance performance and nutritional value. This plays well into the rising trend of specialty fertilizer and soil amendment products; the pelletizing process opens the door to a more specialized approach to fertilizer and soil amendment production.

#### ***Improved control of the characteristics of finished products***

The use of a pelletizing plate, as the most commonly used device, which allows flexibility in managing the process, allows manufacturers improved control over the input material, which is reflected in the possibility of changing the required recipes, in order to meet market requirements. By adjusting and changing certain parameters of the pelletizing plate, manufacturers can target certain characteristics of the finished product [4], such as:



- Particle size distribution (PSD)
- Rate of dissolution
- Crush strength
- Delivery rate
- And more

### ***Increased Blending Potential***

Unlike powdered or pulverized products, pelletized gypsum can be easily blended with other granular fertilizer and soil amendment products. This gives producers the opportunity to increase their offerings by creating different blends, or by selling their gypsum to fertilizer blending plants.

### **Conclusion**

Manufacturers interested in exploring pelletizing as a method of processing their material can use the test facilities to try out their unique source of pelletizing gypsum.

Gypsum process development testing not only demonstrates proof-of-concept and proof-of-process, but also allows manufacturers to gather the data necessary to scale up processes and design equipment on a commercial scale.

Testing determines certain characteristics of starting materials and finished products, which is necessary for the proper management of the pelletization process, as well as for the characterization of the results obtained by the pelletization process. Within the mentioned characterization, it is necessary to determine the granulometric composition of the starting materials, the chemical composition of the starting materials, as well as the granulometry of the obtained products, the chemical composition of the finished products, impact resistance, pressure resistance, abrasion resistance, resistance to disintegration in water, pellet solubility under the influence of atmospheric conditions and the influence of wind strength on the blowing of pellets from the field (important for application conditions in agriculture). Most of these features, ie. their required values in different areas are regulated by certain standards or regulations.

While powder and powder gypsum products have long been the agricultural industry standard for field applications, the advantages that pelletized products can provide are seeing products move towards this alternative. The product offers benefits not only to growers, but also to fertilizer and soil amendment manufacturers.

Testing is a critical aspect of developing a successful pelletized gypsum product, due in large part to the variation shown in different sources.

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### **References**

1. Feeco international, Agglomeration handbook, <https://feeco.com/literature/>, last accessed April 6, 2023,
2. Feeco international, Agglomeration equipment basics, <https://feeco.com/literature/>, last accessed April 6, 2023,
3. Pietsch, W., 2001, Agglomeration Processes – Phenomena, Technologies, Equipment; Wiley-VCH Verlag GmbH: Weinheim, Germany,.

4. Petrović M.; 2008; Mineral Processing – Fundamentals of Agglomeration, Faculty of Mining, Geology and Civil Engineering: Tuzla, Bosnia and Herzegovina; p. 288.
5. Jovanović V., Todorović D., Ivošević B., Radulović D., Milićević S., Mihajlović M., 2022., Pelleting process, required equipment and benefits of use, 8th Balkan mining congress, Belgrade Serbia, Editors: Slobodan Vujić, Milinko Radosavljević, Svetlana Polavder, Organizer: Mining Institute Belgrade, p 314-320, ISBN 978-86-82673-21-7

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