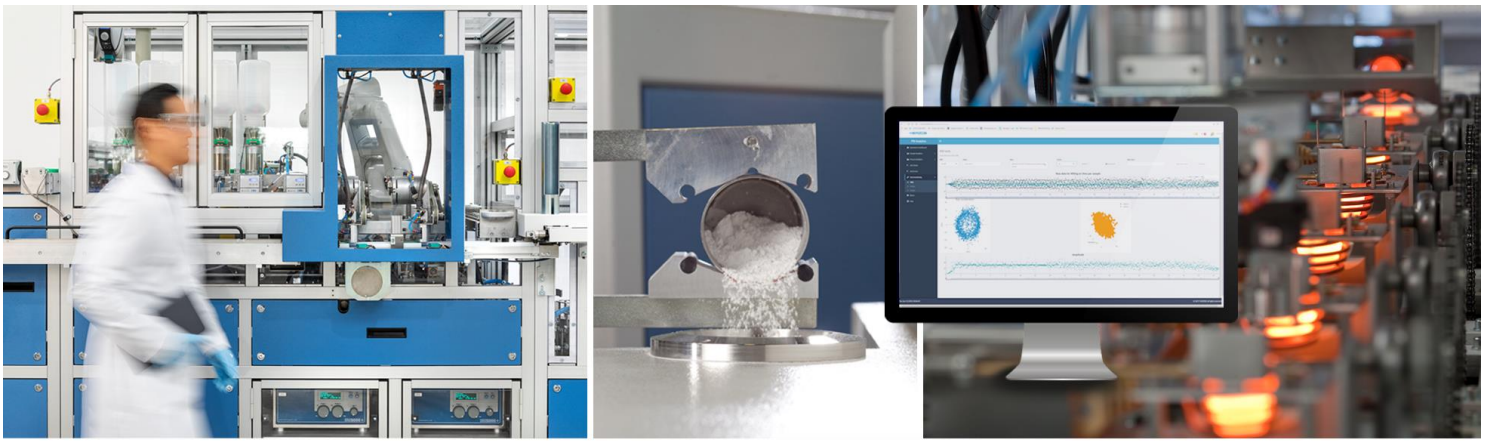
Application note No. 58 | 2024



Assessment of grindability in slag sands by using a laboratory disc mill: Influence of the input grain size

Abstract

This application note explores the influence of particle size on the grindability of slag sands using the Herzog vibratory disc mill. We compared results from samples with grain sizes below 1 mm and below 5 mm, alongside the traditional Zeisel test. The study utilized four slag sand samples from various steel plants, each subjected to different grinding durations. Findings indicate that limiting the particle size to below 1 mm results in more consistent and predictable grindability curves, closely aligning with Zeisel test outcomes. This reduction in variability is attributed to the higher homogeneity of the < 1 mm samples, leading to a more uniform grinding process. The Herzog vibratory disc mill, coupled with PrepMaster Analytics software, offers a rapid, reliable, and user-friendly alternative to the Zeisel test, making it ideal for quality control laboratories. This method enhances efficiency in production processes by providing quick and accurate grindability assessments, ultimately aiding in better decision-making and product quality assurance.

Key words

• Grindability • Grain size • Vibrating disc mill • Slag sand • Zeisel test

Introduction

In our previous application notes [1, 2, 3], we introduced a new method for determining the grindability of clinker and slag sands using a Herzog vibratory disc mill. This method is user-friendly for any quality control laboratory and provides results within 60 minutes. In contrast, the traditional Zeisel test, a standard in the cement industry, is limited to specialized laboratories and can take several days to yield results [4].

Our studies showed that the results from the Zeisel test and the vibratory disc mill were comparable. However, there was a significant difference in the input grain sizes: the Zeisel test used grains between 0.75 and 1.00 mm, while the vibratory disc mill used grains between 0 and 5 mm.

This study focuses on how grain size affects grindability results in the vibratory disc mill. We compared the outcomes using grain sizes below 1 mm to those using grain sizes below 5 mm and the Zeisel test.

Methods

We used the same four slag sand samples from various steel plants as in our previous study [3]. Grindability was tested using Herzog's combined milling and pelletizing machine (HP-MP, Figure 1) with the standard TCM module.

Figure 1: Combined vibratory disc mill and pelletizing machine type HP-MP

Each sample was ground for five different durations (20, 55, 90, 130, and 170 seconds) at 800 rpm and a constant temperature of 35 °C. We used pre-dried samples without any grinding aid. After grinding, we measured the particle size distribution and specific surface area using granulometry (Mastersizer 3000, Malvern, UK). The grinding power was recorded at 100 Hz, and from this data, we calculated the specific energy demand.

Results

Grain Fraction < 1 mm

The specific surface area of the ground material was plotted against the specific energy demand for the different grinding times. The plots showed a nearly linear increase (Figure 2).

The grindability results varied among the samples. Slag sand #4 had the highest fineness, ranging from 2650 cm²/g to 5500 cm²/g, while slag sand #1 had the lowest, ranging from 2050 cm²/g to 4600 cm²/g. Slag sands #2 and #3 fell in between.

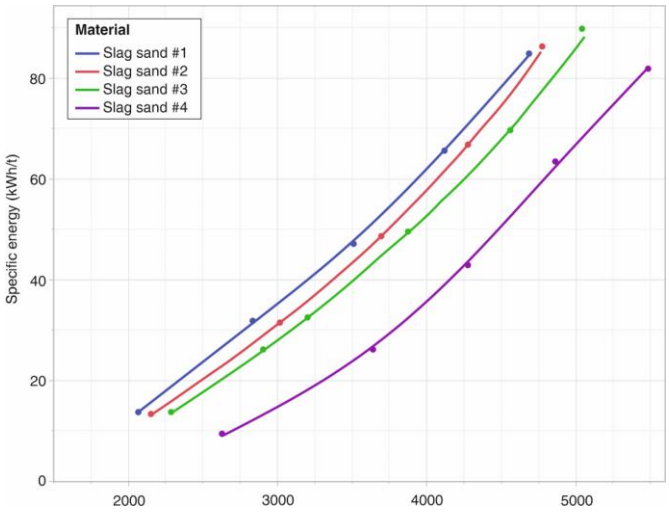


Figure 2: Grindability curve for slag sands < 1 mm as assessed by the HP-MP

Comparison to Grain Fraction < 5 mm and Zeisel Test

When comparing grain fractions < 5 mm, the relative order of grindability remained the same among the samples (Figure 3). However, the distance between the curves changed. For grain sizes < 1 mm, the plots for slag sands #1, #2, and #3 were closer together, while slag sand #4 was significantly different. This pattern closely matched the Zeisel test results (Figure 4).

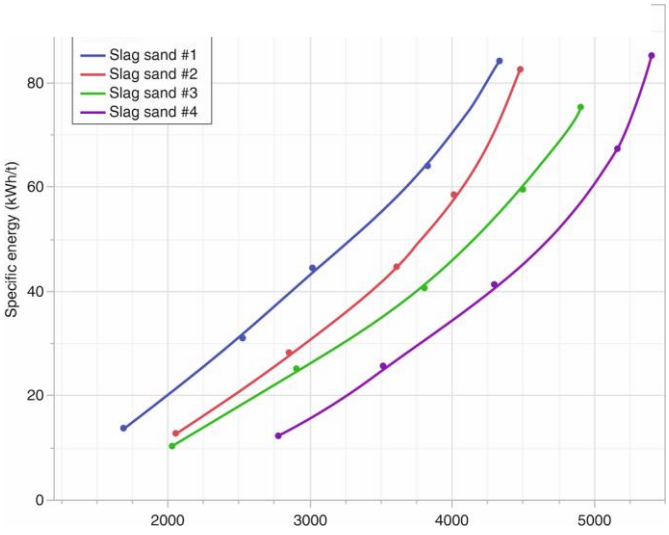


Figure 3: Grindability curve for slag sands < 5 mm as assessed by the HP-MP

The grindability curves for grain sizes < 1 mm were more consistent and had less variability than those for grain sizes < 5 mm, indicating a more predictable grinding process.

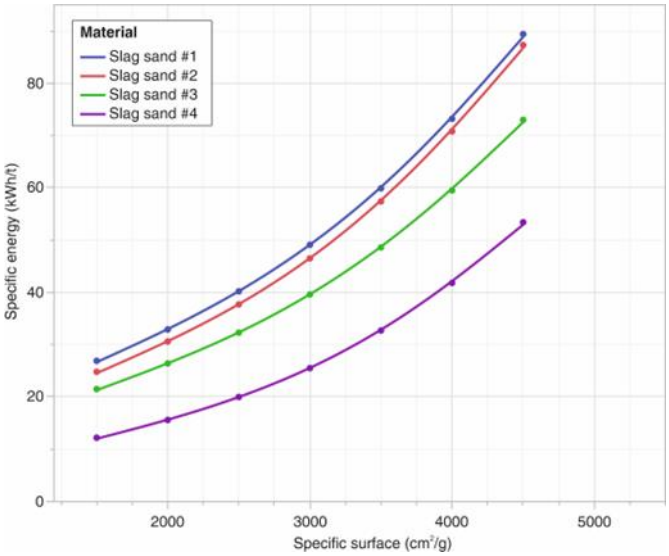


Figure 4: Grindability curve for slag sands as assessed by the Zeisel test

Discussion

The main outcome of this study was that limiting the grain size to below 1 mm reduces the variability of the grindability curves and enhances their similarity with the Zeisel test results. This consistency is crucial for ensuring reliable and repeatable results in quality control processes. The higher homogeneity of the grain size in the < 1 mm fraction results in a more predictable grinding behavior, which is reflected in the smoother and more uniform grindability curves.

The significant reduction in variability observed in the < 1 mm fraction suggests that the Herzog vibratory disc mill is highly sensitive to differences in sample composition. This sensitivity is particularly beneficial for detecting subtle variations in material properties, which can be critical for optimizing production processes and ensuring product quality. The less variable and more uniform grindability curves obtained with the < 1 mm fraction indicate that this method provides a more accurate representation of the material's grindability.

The comparison with the Zeisel test further corroborates these findings. The Zeisel test, known for its high degree of uniformity and minimal variability, uses a highly homogeneous sample. The close resemblance between the grindability curves of the < 1 mm fraction and the Zeisel test highlights the importance of sample homogeneity in achieving consistent and reliable grindability measurements.

Overall, this study demonstrates that the Herzog vibratory disc mill is a viable alternative to the Zeisel test for assessing grindability. Both methods yield comparable results, but the Herzog method offers significant advantages in terms of speed and ease of use. The ability to obtain rapid results within 60 minutes, compared to several days with the Zeisel test, allows for more efficient and timely decision-making in quality control and production processes.

References

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