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MVR vertical roller mills for the limestone industry – operating experience in the field of fine grinding

MVR-Walzenschüsselmühlen für die Kalksteinindustrie – Betriebserfahrungen bei der Feinmahlung

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SUMMARY

Lime is one of the most important raw materials for mankind and was already used as mortar 14000 years ago. The importance of the material has increased steadily. In the iron and steel industry, in construction or agriculture, in road construction and in countless chemical production processes, lime is an essential agent. For the main products of the lime industry, such as ground limestone and hydrated lime, Gebr. Pfeiffer SE with its headquarters in Kaiserslautern offers equipment such as vertical roller mills, high-efficiency classifiers and lime hydrators. For limestone grinding, the MPS mill is a proven and well-known machine, which is installed in numerous plants. With the development and introduction of the MVR mill, which was first used in the cement sector, another vertical roller mill is now available, also for limestone grinding. This mill type covers a wide range of throughput rates. With the MVR mill very fine limestone products finenesses of up to 10 µm with very small residues can be realized. With additional equipment, such as the grit discharge, a wide range of product characteristics can be produced with the system.

ZUSAMMENFASSUNG

Kalk ist einer der wichtigsten Rohstoffe für den Menschen und fand schon vor 14000 Jahren Anwendung als Mörtel. Die Bedeutung des Materials hat stetig zugenommen. In der Eisen- und Stahlindustrie, in der Bau- oder Landwirtschaft, beim Straßenbau, im Umweltschutz oder in unzähligen chemischen Herstellungsprozessen hat sich Kalk zu einem unverzichtbaren Wirkstoff entwickelt. Für die Hauptprodukte der Kalkindustrie wie Kalksteinmehl und Kalkhydrat bietet die Gebr. Pfeiffer SE aus Kaiserslautern solche Maschinen und Ausrüstungen wie Walzenschüsselmühlen, Hochleistungssichter und Kalklöschmaschinen an. Für die Kalksteinmahlung ist die von Gebr. Pfeiffer angebotene MPS-Walzenschüsselmühle eine bewährte und bekannte Maschine, die deshalb auch in vielen Anlagen installiert wurde. Mit der Entwicklung und Einführung der MVR-Mühle, die zuerst im Zementbereich eingesetzt wurde, ist nunmehr auch für die Kalksteinmahlung eine weitere Mühle verfügbar, die einen breiten Durchsatzbereich abdeckt. Mit dieser Mühle können sehr feine Kalksteinprodukte mit Mahlfeinheiten von 10 µm bei kleinsten Rückstandswerten produziert werden. Mit zusätzlicher Ausstattung wie dem Grießeaustrag ergibt sich eine Vielzahl von Produkteigenschaften, die mit dem System erfüllt werden können.

(English text supplied by the authors)

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1 Introduction

In the mid-1960s, Gebr. Pfeiffer SE, Kaiserslautern, successfully recorded its first references in the use of vertical roller mills for grinding limestone. Among the number of international references, which has increased over the years, there are not only the lime and cement branch, but also the chemical and steel industry as major fields of application. The grinding fineness degrees of all the limestone mills in operation range from 0.1 % R 20 µm to 50 % R 160 µm at throughputs from 1 to 70 t/h. Depending on the requirements on the finished product throughput and the product fineness, the mill dimensions, measured on the outer diameter of the grinding plate, vary from 800 to 3350 mm. The installed power of the mill drives, as a function of the grindability of the limestone and the product and process requirements dimension, ranges from 41 to 1 100 kW.

2 Comparing vertical roller mill technology – MVR versus MPS

Based on the historical development, in most cases an MPS vertical roller mill (❱ Fig. 1, left), is used for grinding limestone. Thanks to continuous improvement, this technology has proven itself over decades and actually represents a truly universal solution for grinding, separating and drying various materials. Properties such as reliability, energy efficiency and long service life are only some of the outstanding features that have contributed to the success of the MPS technology, also in the field of limestone grinding.

In view of increasing demands on production capacity and availability, the MVR vertical roller mill (Fig. 1, middle, right), was developed and introduced in 2006. The MVR concept was primarily developed for cement and cement raw material grinding. Compared to the traditional MPS mill, the main differences are limited to the grinding tool geometry, the design of the roller modules and the drive concept of the grinding bowl. Mill components impacting the gas flow, such as the high-efficiency classifier (type SLS), the hot gas ducting and the nozzle ring, are unchanged from the proven MPS mill design. In contrast to the three spherical grinding rollers of Pfeiffer MPS mills, the MVR vertical roller mill is equipped with up to six cylindrical grinding rollers and a flat grinding plate. A hydro-pneumatic system ensures that the material to be ground between the grinding rollers and the grinding plate is predominantly exposed to pressure load. Thanks to the geometry of the grinding elements, a parallel grinding gap is formed, which ensures an even compression of the material to be ground and has a positive effect in view of smooth running.

In order to increase the availability, the design of the roller module provides for a new type of roller arm bearing for the grinding roller axle on twin supports. With this concept, which is called active redundancy, it is possible to swing out or lift individual grinding rollers and continue production with the other grinding rollers. Maintenance and operation can thus be combined via a single hydraulic unit. Compared to MPS mills, the higher number of grinding rollers and the design of the MVR roller modules make it possible to increase the total load on the material to be ground and to increase the performance.

With regard to high throughput rates, the patented MultiDrive® is offered besides the conventional drive. In the unlikely event of a drive failure, the drive unit can be decoupled, and grinding can continue, maybe at a reduced throughput rate.

Figure 1: Gebr. Pfeiffer's vertical roller mills – MPS mill (left), MVR mill with MultiDrive® (middle) and MVR mill with conventional drive (right)

Figure 2: First MVR vertical roller mill for fine grinding of limestone – product fineness degrees up to 0.1 % R 20 µm

3 Limestone grinding with MVR mills – example from the practice

Based on the improvements that result from the use of an MVR vertical roller mill and the operating experience gained with MPS mills, MVR technology can be used for grinding limestone as well as for cement and cement raw materials. Among the references, a particularly fine product with a fineness of 0.1 % R 20 µm deserves attention. This material fineness is produced using a vertical roller mill under the designation MVR 1800 R-4 with a grinding table diameter of 1800 mm. The grinding plant mentioned in ◗ Fig. 2 is the first MVR limestone grinding plant erected in Germany. This grinding plant sets high standards right from the start.

The mill is equipped with an SLS 1800 BF high-efficiency classifier (rotor diameter: 1800 mm), which is designed for a maximum rotor speed of 600 min^{-1}. In the field of fine grinding and classifying, avoiding nibs and having a high classifier speed are essential for achieving sharp separation curves. For this reason, the annular gap of high-efficiency classifiers is additionally pressurized with sealing air, thus ensuring optimum sealing. A vertical roller mill of the type MPS 160 A with a grinding plate diameter of 2000 mm is also installed in the plant. Whereas the MPS mill produces fineness degrees from approx. 1 % R 63 µm to approx. 5 % R 90 µm, the MVR mill delivers products with a fineness within the limits of the particle size distributions shown in ◗ Fig. 3.

The particle size distributions of the operation samples were determined by laser diffraction with a Malvern Mastersizer 2000. The particle sizes d_{10}, d_{50} and d_{90}, listed in ◗ Table 1, as well as the particle diameter d' and the slope n of the RRSB distribution can be calculated from the laser granulometric measurement.

The MVR mill not only produces a wide range of product fineness degrees, it also has a special constructive feature: it can produce two products simultaneously in only one grinding mill. In addition to the quantity of fines produced,

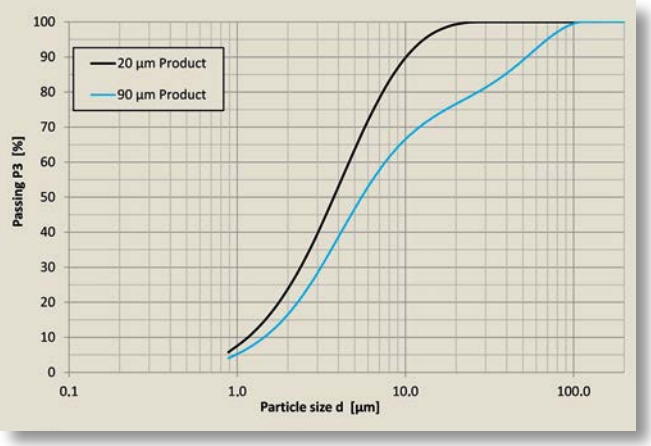

Figure 3: Particle size distribution from samples from the MVR mill 1800 R-4 for limestone

Table 1: Analysis of samples as to particle size determined by Laser Diffraction (Malvern)

Operation sample	d_{10} [µm]	d_{50} [µm]	d_{90} [µm]	n [–]	d' [µm]
20 µm product	1.2	3.8	10.1	1.36	5.1
90 µm product	1.4	5.5	52.6	0.67	11.4

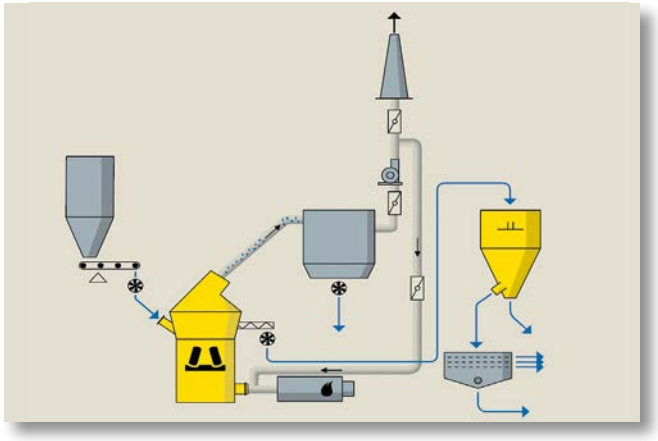

Figure 4: Exemplary process flow diagram with grit discharge and subsequent separating

classifier grits are discharged below the classifier cone via a screw conveyor. The obtained grits are used as fertilizer in agriculture or as an additive in the animal feed industry. The simultaneously produced fines are used, for example, as a filler in both the paper and construction industries or for the production of various end products in the ceramics, plastics and chemical industries. An exemplary process flow diagram with grit discharge and subsequent separating and screening of the grits is shown in ◗ Fig. 4.

This shows clearly that limestone is of great economic importance alongside other basic materials such as coal, crude oil and iron ore. The above-mentioned fields of application and the large number of possible uses, result in a broad range of product requirements, similar to those of cement. To ensure that the product requirements can be guaranteed, the rating of vertical roller mills always requires individual and material-specific consideration.

4 Rating of vertical roller mills

The design of an industrial grinding plant is based on tests with a pilot plant on a laboratory scale. The design of the test mill is similar to the later industrial mill and ensures the transferability of the parameters relevant for the rating of the industrial mill.

Ideally, a representative sample of the feed material used later on for the industrial application is ground in the test mills available in the test station (◗ Fig. 5). Both stable and unstable operating conditions of variable product fineness are investigated during the tentative tests, of which only the stable and loadable conditions are ultimately selected for dimensioning. Especially the throughput rate and the specific energy consumption when obtaining the project-relevant product fineness are decisive for the rating of design and process. However, the wear behaviour of the grinding elements, the mill housing and the classifier are also determined during the tests on the basis of characteristic values for the wear rate and jet wear. With the help of these values, it is possible to select the optimum wear materials for the subsequent large-scale plant in order to guarantee the longest possible service life.

When carrying out rating tests and investigations with the focus on research and development, significantly higher fineness degrees can be achieved than those shown in the practical example of the vertical roller mill MVR 1800 R-4.Under stable and reliable operating conditions, it was possible to grind limestone to a fineness of 3 % R 10 µm. The corresponding

Figure 5: Gebr. Pfeiffer's test station – test mills – MVR 400 in the foreground, MPS 32 in the background

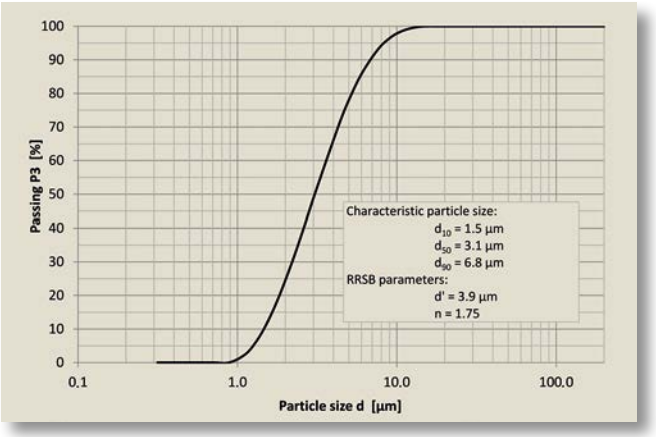

Figure 6: Particle size distribution of ground limestone with high fineness

particle size distribution of the analysed ground product was determined by laser diffraction and is shown in ◗ Fig. 6.

Particle size distributions, as shown in Fig. 6, reflect the current trend towards ever higher product fineness degrees. Such a grinding fineness requires a sufficiently high energy input. Due to the efficient comminution principle and the high-efficiency classifier, the MPS and MVR mills require up to 40 % less electrical energy in comparison to conventional ball mills, and finally prove to be clear favourites.

5 Final remarks

The performance of a vertical roller mill depends on many factors. The feed material is the basis for the required properties of the finish product. The new technology of the MVR mill, available on the market for the past fifteen years, is the right choice for handling of versatile feed components. In combination with increased plant availability and ease of maintenance the MVR mill offers low specific electric and thermal energy consumption. In the field of limestone grinding, the MPS mill is a proven and well-known machine with a great number of references. With the introduction of the MVR mill, another vertical roller mill is now available for various applications. The MVR mill is also used for limestone grinding, as this mill type allows a very wide range of throughput rates. With the MVR mill, very fine limestone products with a low percentage of residue on 10 µm can be achieved. With additional equipment, such as the grit discharge, a wide range of product characteristics can be achieved with this grinding system. For the lime industry, Gebr. Pfeiffer offers further equipment such as high-efficiency classifiers and lime hydrators, which, together with the use of an MVR mill, offer a broad portfolio for the processing of quicklime and the production of hydrated lime. ◀