# GRINDING WITH MVR

**Dr Caroline Woywadt, Gebr. Pfeiffer,** discusses recent grinding projects with MVR mills.

## Introduction

The development of the MVR mill in combination with the development of the MultiDrive® system in cooperation with Flender has consequently raised the potential of the MVR mill with respect to performance, reliability, and availability.

| *Table 1.* Operating data for slag cements produced in a MVR 6700 C-6. | | | | |
|---|---|---|---|---|
| | **CP III 40** | **CP II 32** | **CP V Ari** | **CP V Ari Plus** |
| **Mix** | 40% slag<br>3% limestone | 34% slag<br>9.5% limestone | 20% slag<br>2% limestone | 0% GBFS<br>94% clinker<br>3% limestone |
| **Product rate** | 395 tph | 456 tph | 349 tph | 178 tph |
| **SPC mill** | 28.5 kWh/t | 21.9 kWh/t | 27.3 kWh/t | 41.4 kWh/t |
| **Feed moisture** | 2.9 % | 3.2 % | 1.9 % | 0.3 % |
| **Fineness** | 4670 Blaine<br>3.4% R 38 µm | 4420 Blaine<br>2.0% R 45 µm | 4850 Blaine<br>2.1% R 38 µm | 5500 Blaine<br>0.9% R 38 µm |
| **Vibrations** | 0.8 mm/sec. | 0.7 mm/sec. | 1.2 mm/sec. | 1.2 mm/sec. |

Figure 1. MVR 3750 C-4 in East Africa.

The running times that have now been achieved with completed plants and the satisfaction of the customers confirm the correctness of the chosen mill and drive system. The need for high plant availability and an optimised maintenance concept is becoming increasingly important.

Contrary to high-capacity plants, very compact systems with short time to market entrance are required as well. The modular mill solution enables flexible use in any place, bringing cement producers closer to their customers. This compact system is suited to the production of all types of cement: perfect for local cement producers and market entrants, as well as for large construction companies aiming to expand their position by manufacturing cement on the spot.

The ready2grind plant from Gebr. Pfeiffer can be transported and erected quickly and efficiently with manageable costs, making it an ideal concept to respond rapidly to the changing needs of the local cement markets.

In the last decade, more than 70 MVR mills have been sold. The first MVR mills have been installed in Europe for cement raw material and cement grinding. These mills have been in operation since 2007 and 2008, respectively. Meanwhile, the MVR population has increased continuously. In this article, operating data of several MVR mills installed worldwide will be discussed in detail. Operating results of the biggest cement mills (MVR 6700 C-6) will be highlighted. The production of portland cement with very high fineness of more than 5000 Blaine is possible with a smoothly running mill.

## Design features

The design features of the MVR mill differ mainly from the well-known MPS mill in the grinding element geometry, the roller suspension, and the number of rollers. All machine parts that are relevant in terms of fluid dynamics, such as the hot gas channel, nozzle ring, SLS high-efficiency classifier, and material feed, are of the same design as the those parts in MPS mills.

The MVR mill is capable of producing high output rates of up to 1000 tph raw material. The modular design of the MVR mill, comprising four to six grinding rollers, allows the continuation of mill operation, even if one roller module is not available. The same applies to the MultiDrive® design of the mill drive: the mill is driven through a girth gear flanged to the grinding bowl by up to six actively redundant drive units with a total output of up to 18 000 kW. Each drive unit consists of an electric motor, coupling, and gear unit. The grinding forces are transmitted to the foundation via a conventional plain bearing without placing any load on the gear units; the gear units are therefore not exposed to the grinding forces.

## Projects and operational results

So far, the biggest mill with an 11 500 kW mill main drive is in operation in Brazil. This MVR 6700 C-6 produces portland slag cement (PSC) with different ground blastfurnace slag (GBFS) proportions of up to 50%.
The civil works, as well as the mechanical and electrical installation, were finished in September 2015.
Hot commissioning took place in April 2016. Table 1 shows the operating data achieved during the performance test.

| *Table 2.* PT Data of MVR 3750 C-4 for PPC grinding. | | |
|---|---|---|
| | **Guarantee** | **Current*** |
| **Material** | PPC (25 – 28% pozzolana) | |
| **Production rate** | 151 tph | 156.5 tph |
| **Blaine** | 4000 cm²/g | 4190 cm²/g |
| **Specific energy consumption (shaft: mill, classifier, fan)** | 28.86 kWh/t | 26.53 kWh/t |
| **Vibration (gear box base plate)** | n.a. | 0.5 mm/sec. |
| *According to performance testing in June 2018. | | |

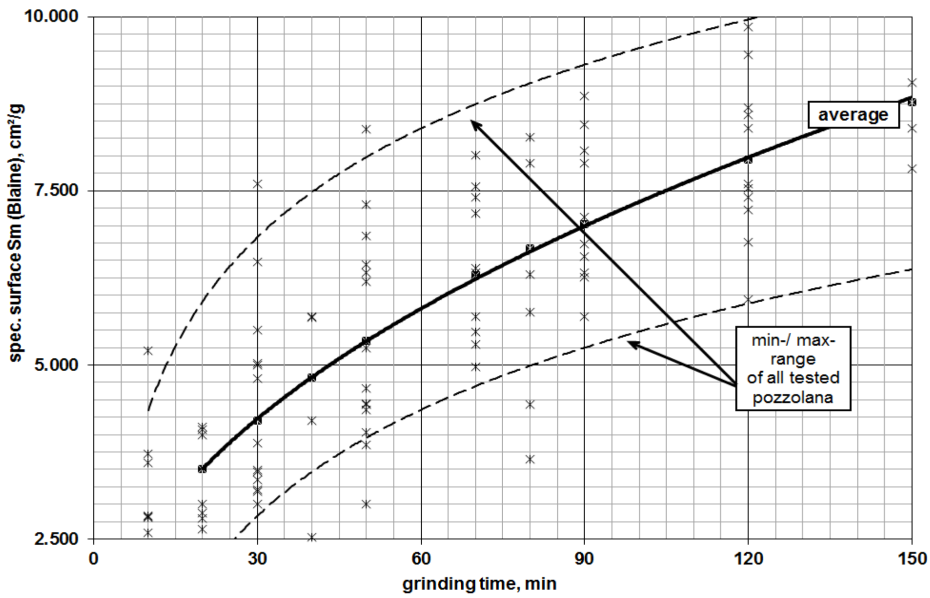


Figure 2. Grinding of pozzolana with laboratory ball mill: Blaine as function of grinding time.

## Pozzolan cement

A grinding plant producing a composite cement with pozzolana as a clinker substitute has been taken into operation lately in Africa. The installed MVR 3750 C-4 (Figure 1) is rated to produce between 150 and 180 tph PPC at 4000 cm²/g acc. Blaine, depending on the grindability of clinker and pozzolan. The mill is equipped with a main drive power of 2900 kW. Table 2 show the results achieved.

Pozzolanic materials do not harden in themselves when mixed with water but, when finely ground and in the presence of water, they react at normal ambient temperature with dissolved calcium hydroxide ($Ca(OH)_2$) to form strength-developing calcium silicate and calcium aluminate compounds. These compounds are similar to those that are formed in the hardening of hydraulic materials. Pozzolanas consist essentially of reactive silicon dioxide ($SiO_2$) and aluminium oxide ($Al_2O_3$). The remainder contains iron oxide ($Fe_2O_3$) and other oxides. The proportion of reactive calcium oxide for hardening is negligible. The reactive silicon dioxide content shall be not less than 25.0% by mass (EN 197-1).

In East African countries, the most available material as supplement is limestone. Limestone dilutes the clinker content of the cement and impacts the strength development. If natural pozzolana is available, cement manufacturing is more profitable due to the properties of pozzolana. The definition of pozzolana includes any volcanic material. In difference to that the term, pozzolan does not describe the specific origin of the material.[1] Therefore, the term pozzolan also includes artificial supplementary materials, such as flyash, bottom ash etc.

The great majority of natural pozzolans is of volcanic origin. The global distribution of volcanic rocks can be compared with the occurences of natural pozzolan deposits. But not all volcanic rocks are suitable as pozzolanic material. More siliceous magma produces more explosive volcanism with better pozzolanic properties.[2] The activity of

The flexibility of the equipment allows the production of ordinary portland cement (OPC) up to at least 5500 Blaine, which was not defined in the project. The mill operates with a smooth level of vibration. The plant was running the mill without the supplier's supervisor after 79 hours of commissioning.

The overall results achieved in all MVR mills show that all required cement qualities can be produced in vertical roller mills. The combination of drying, grinding, and separation in one system is advantageous, especially when it comes to clinker substitutes. A smooth and stable mill operation with reduced water spray is possible; grinding without external heat is thus dependant on feed moisture of the material.

In all Pfeiffer mills installed in India for example, the performance guaranteed could be achieved easily. The clinker temperature impacts the process conditions: if the temperature is low or ambient, the amount of water spray has to be lower to fulfill the thermal process balance. With a higher clinker temperature, the amount of water injection or feed moisture can be higher. When laying out a grinding plant, the installation of an external heat source is recommended, even when starting the plant with OPC or portland pozzolana cement (PPC) with dry flyash only, because wet additives might be used in future.

Figure 3. MVR 3750 C-4 under construction in South Africa.

Figure 4. MVR 5300 C-6 under construction in Europe.

Figure 5. MVR 5000 R-4 under construction in Uzbekistan.

some pozzolanas, for example phonolith, can be increased by thermal treatment. By heating up to 300°C to 500°C, the crystal lattice expands and the surface area increases. Thereby the formation of hydrate-phases is supported.[3]

The grindability of natural pozzolana varies widely. In Figure 2, the specific surface area acc. to Blaine depending on the grinding time is shown. For achieving 5000 Blaine, for example, a time of exposure in the laboratory ball mill is between 30 min. to 75 min. This behaviour has to be taken into consideration for rating the industrial mill. Additionally, the reactivity of pozzolanas is very different and has tremendous impact, in combination with the clinker, on the produced cement. Therefore, a fine adjustment of feed material properties and target fineness of finish product need to be done.

## Final remarks

Many MVR mills are under execution and erection. For example, in South Africa, a second MVR 3750 C-4 is under erection. Figure 3 shows the progress of construction work. This mill will be capable of producing CEM I, CEM II/B-L, and CEM III/A with output rates of up to 110 tph at 4500 Blaine. Commissioning will take place in Autumn 2018. Another MVR 5300 C-6 mill is under erection in Europe. This grinding plant will cover a wide range of products: from CEM I to CEM III/C with fineness up to 5200 Blaine. Figure 4 shows the status of erection. This mill is equipped with a conventional drive with a rated power of 4600 kW.

MVR mills are not only proven for cement grinding, but also for cement raw material grinding. A mill of the size MVR 5000 R-4 installed in Uzbekistan (Figure 5) is grinding cement raw material with a higher than guaranteed capacity of 410 tph at 12% R 90 μm.

During the past decade more than 70 mills have been sold. A large number of those mills is in operation for production of a wide range of materials. The MVR mill technology, which has been available on the market for the past 10 years, is the right choice for the 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.

## References


1. CLARK, M., "Pozzolana is the key", *ICR* (November 2017), pp. 48 – 49.
2. SNELLINGS, R., MERTENS, G., and , ELSEN, J., "Supplementary Cementitious Materials", *Reviews in Mineralogy and Geochemistry*, 74 (2012), pp. 211 – 278.
3. KASSAUTZKI, M., "Phonolith als puzzolanischer Zumahlstoff in der Zementindustrie", *ZKG* (1983), pp. 688-692


## About the author


Dr Caroline Woywadt has been Director – Process Technology at Gebr. Pfeiffer since 2011. After graduating from RWTH Aachen, Germany, with a degree in mineral processing and a PhD in the field of grinding, she worked as a process and quality control manager at cement grinding plants in Germany and Poland, as well as a product manager for grinding products.