

Interview by Peter Edwards, Global Cement Magazine

Looking to the future at Gebr. Pfeiffer

We delve into the future of cement sector grinding with Gebr. Pfeiffer's Patrick Heyd...



Above: Patrick Heyd has been the Executive Director for Sales and Project Engineering at Gebr. Pfeiffer since 2014. He joined the company in 1995 as a project engineer after a period working with coal and petcoke mills in the power generation sector. Patrick has also previously worked as Area Sales Manager for China and South East Asia for Gebr. Pfeiffer.

Global Cement (GC): Please could you introduce the company Gebr. Pfeiffer?

Patrick Heyd (PH): Gebr. Pfeiffer was founded by the brothers Karl and Jacob Pfeiffer as a small machine factory in Kaiserslautern, Germany, in 1864. Its first products were steam engines and, early on, various mills and wind separators. Very soon the company focused mainly on the building materials industry, with an international orientation.

GC: What are its main types of mill?

PH: The company sold its first vertical roller mill in the 1950s, which later became a success under the MPS name. These have three grinding rollers with a rounded edge that run on a moulded grinding table with a groove. The rollers are held in place by a pressure frame that presses the rollers onto the grinding bed formed on the table. The first MPS mill for cement (the world's first vertical cement mill ever) was ordered in 1979, commissioned in 1980 and remains in operation 40 years later in 2020. MPS mills are well

suitable to moist materials, several of this type are in operation, which process raw materials with a feed moisture of up to 25%. There are several thousand Pfeiffer vertical mills operating in various sectors.

We started to work on the MVR design in the early 2000s and gained our first industrial operating experience in 2006, with two 'under-the-radar' projects: one in Germany and one in Bosnia & Herzegovina. Once the concept was proven, we introduced the MVR mill to the market in 2010.

Unlike MPS mills, MVR mills have cylindrical rollers and a flat grinding table. Each roller has its own hydraulic suspension and roller arm, which means you can change the number of rollers and even remove some for maintenance while keeping the others operating under a partial load. This is known as 'active redundancy.'

The largest MVR mill is in operation at the LafargeHolcim Barroso plant in Brazil. It produces up to 460t/hr of various slag cements and 178t/hr of CEM I cement with a specific surface of 5500cm²/g (acc. to Blaine). This mill is equipped with an installed drive power of nearly 12,000kW. At present our biggest MVR mills for raw material grinding typically operate at 800t/hr, which is the nominated capacity to serve a 10,000t/day kiln.

GC: How did the company traditionally improve upon its designs?

PH: Gebr. Pfeiffer traditionally approached design improvements from three sides. Firstly, we have a sophisticated process design department with a test station and laboratory that work out the parameters for ideal process design. Secondly, there is the experience coming from the field and thirdly, the mechanical design of the equipment itself, i.e.: proper analysis of the stress and strain within the material of the mill. This provides a 'reality check' on the process designs and allows us to scale up the design to industrial scale. Here it is important that all departments involved collaborate well, otherwise the mill could be oversized. This approach relied on a lot of experience, both from the testing facility and real-world installations.

GC: What about product development in 2020?

PH: The previous approach was very iterative and took a lot of time to produce improvements. Nowadays our clients want faster and faster development. To achieve this, we manage an innovation funnel with universities, institutes and development partners. We have gained a lot of experience with computer-aided tools in recent years and use them to identify promising development paths more rapidly. Keywords are 'simulation of grinding processes' and the use of



‘digital twin’ technology. Furthermore, we use two-phase computational fluid dynamics (CFD). Two-phase CFD enables us to look at the air volume and the dust flow at the same time. Finite element analysis (FEA) is used to analyse the stresses and strains within the mechanical structure of potential designs.

Our computer-aided tools have cut down development time massively. Of course, you won’t see improvements without direction from experienced human design teams but we can now learn more quickly than in the past thanks to these tools.

Gebr. Pfeiffer also uses an approach known as Value Engineering, where representatives from different departments ‘workshop’ together to identify the current barriers to improvement and how they can be circumvented. This is a collaborative process that seeks to improve the product as a whole, as well as pick up on specific targets for improvement.

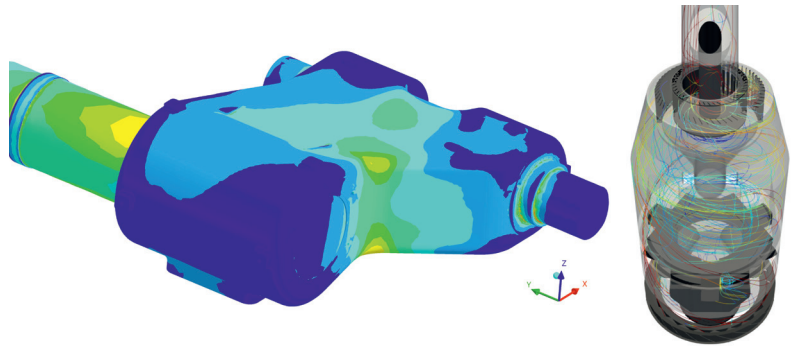
GC: What are Gebr. Pfeiffer’s main development targets at the moment?

PH: There are three main areas in which we constantly strive to improve: Sustainability, Efficiency and Digitisation. These are intrinsically linked. Sustainability has come to the fore, quite rightly so, because our clients want to (and are required to) improve their environmental performance and energy use. Efficiency is important for sustainability, as well as for the reduction of production costs. Digitisation feeds into the ease of use of the mill, as well as its process efficiency and, hence, sustainability.

Our consistent product development is oriented to the needs of our clients. Some achievements include: a 10% increase in power density of the current MVR series; increased specific dust load after the mill, which leads to a reduced gas volume flow in the plant; and lower plant fan power consumption. The separation efficiency of our classifiers has also been further increased. Of course we are not only looking at the mill itself, but also at the complete grinding plant. Here, pressure losses have been reduced by further optimising the ducting of our compact grinding plants. These are just a few examples of our activities that save further energy and thus also resources in general, since fewer raw materials have to be used, which only underlines the fluid transition between efficiency and sustainability.

GC: Which is the most important of these three for your clients?

PH: Efficiency is still the starting point for everything. If the mill is not efficient, it will not be sustainable or economical due to excessive power consumption. In future, the economic success of a mill supplier will massively depend on providing best solutions for efficiency, sustainability and digitisation. The mill also



Above: Examples of computer-aided tools. FEM (left) and CFD (right).

affects the efficiency, cost and sustainability of the other parts of the process before and after the mill itself. In answer to the question, all three focuses are very important.

GC: What are the limits to mill design? Will they reach an efficiency or sustainability limit?

PH: Designs that are at one point revolutionary are often replaced by improved concepts. Take drive power for example. Before we launched the Barroso mill, with a rated capacity of 460t/hr for slag cement and nearly 12,000kW of installed power, the largest mill operating in the world had an installed capacity of just 6000kW - half the size!

The power was previously limited due to the design of traditional planetary gearboxes. Our response was the MultiDrive® system, which first went into operation in 2008 and was officially launched together with the MVR mill in 2010. This approach uses up to six drives, rather than one, so that the load is shared. This took our designs back to an area where torque was not only ‘safe’ for installed power of 5000-6000kW, but for as high as 18,000kW.

Of course, planetary gearbox design has come on a great deal over the past 15-20 years, with new designs for inlet and planetary stages for a better balance of torque transfer between the stages, but they cannot offer such high values. In addition, the MultiDrive® system extends the active redundancy to the main drive, because both drives and gear unit can be removed individually from the system and the mill can continue to grind. Together with the rollers, which can be taken out of operation individually, this is the highest level of reliability you can have.

GC: Can you expand on the power density?

PH: Amongst our competitors mill sizes/types are named after the diameter of the grinding table. Mill power is the result of throughput multiplied by specific power consumption. The power density is then the ratio of mill power and mill size.

Throughput can be increased by using a larger table diameter, larger contact area (roller size or number of rollers), faster table rotational speed and higher hydraulic force. Clients are always looking for the best techno-commercial solution. The aim is to

Opposite Page: Double active redundancy: An MVR 6700 C-6 mill in Brazil with a drive power of 11,500kW.

realise this with the most compact design (maximise roller contact area / minimise table diameter). Thus, power density is the benchmark for advanced mill technology.

To illustrate how far power density has come, a 6.6m-diameter MPS mill for a Japanese client, supplied more than 40 years ago, had an installed drive power of just 2700kW. Today, if I wanted a mill with a 2700kW drive, I'd specify a table diameter of approximately 4m. This is due to constant improvement of the power density. This means we don't need as large a table. Of course, the higher the grinding roller contact area, the greater the power density. You only grind under the rollers after all!

GC: What do cement producers look for in terms of the cement product itself?

PH: All of our clients, of course, must meet the requirements of their own clients. Cement is sold on the basis of strength, fineness (Blaine) and a well-defined particle size distribution. In developed markets, this means a trend towards flexibility in cement characteristics. Client A wants cement type 1 and Client B wants cement type 2. This requires a mill that is flexible and can be easily and rapidly tuned to different types of cement and fineness. Vertical roller mills are the perfect answer for that.

In any market with a tendency towards lower clinker factor, our clients are determined to keep the fineness as high as possible. The lower amount of clinker together with the additives in these blends has to work harder to achieve the same strength development and so needs a higher fineness (higher Blaine). Higher Blaine cement is also required due to the decline in overall concrete mass. A reduction in

concrete mass means more sustainability overall.

GC: How do you increase the Blaine?

PH: Higher Blaine is a play-off between the mill and classifier, which must work perfectly together. As well as the mill settings that I already mentioned, we can change several parameters in the classifier, its airflow characteristics, speed and so on.

Also, the finer you grind, the thinner the grinding bed becomes. It is only possible to

maintain a stable and thin grinding bed with a stable mill. Our MVR mill was specially designed to operate perfectly under these conditions and even at very low vibration levels. Typically, vibrations of 2.5mm/s were accepted by cement plant operators as recently as 2010. With the MVR mill for cement grinding, we can now usually achieve vibrations of around 0.5mm/s for standard cements.

GC: How does it do this?

PH: This is to do with the parallel grinding gap. The roller is cylindrical, the table is flat and the gap where the material bed is being formed is the same all the way along. The suspension of the roller arm is only along the vertical axis and there is no interaction between the roller support and the mill housing, other than that it passes through the housing. This means that the torque from grinding process is transferred to the roller support and down to the foundations, not to the mill casing or any other part of the mill.

GC: Will there be a point when the MVR also reaches its technical ceiling?

PH: From today's point of view, our system is highly efficient, but of course we are constantly developing our products in order to improve their capacity, size, efficiency and so on. We currently have six rollers to reach, for cement grinding, capacities of 500-600t/hr. One six-roller 800t/hr raw mill can feed a large 10,000t/day kiln relatively easily, so these are currently the maximum capacities that we are being asked to provide.

This does not mean that larger MVR mills are not possible. Theoretically we could add another two rollers for capacities up to 800t/hr (cement) or 1400t/hr (raw meal), if a cement producer wanted to explore that option. The MultiDrive® allows us to go to 18,000kW so there is a lot of available 'headroom' with this design.

GC: Do you think it would be possible to have a single raw mill feeding two kilns?

PH: I think this is totally feasible and I don't see why one large MVR mill couldn't work at full load across two kilns. Then, due to the active redundancy and MultiDrive® options, you could turn the mill down if one of the kilns were undergoing maintenance. We are prepared for a client that wants to explore the efficiencies that such a large mill would bring.

GC: There have been various modular grinding solutions from a number of suppliers launched recently. Are these efficient and sustainable solutions or 'cheap and cheerful' off-the-shelf models?

PH: I can only speak for our own ready2grind system

Below: The largest mill in Western Europe, an MVR 5300 C-6 in Belgium, is equipped with GPpro.



which has meanwhile proven itself in the field worldwide. It has fewer options than a traditional mill but can still offer efficiency, sustainability and reliability. We developed this range in response to market demand. After the late 2000s financial crisis, there was a realisation that there was severe clinker overcapacity across our industry. At the same time, there were still several markets with relatively poor infrastructure that were natural homes for small grinding plants of 20t/hr. Now these too have moved to larger capacities to save on capital expenditure as much as possible, albeit in a lower 'capacity window.'

Our ready2grind 1800 makes 25-30t/hr, the ready2grind 2500 makes 60-70t/hr and the ready2grind 3000 is already on its way. These grinding plants are perfect for remote areas or when cement production needs to be very close to the cement consumer, even if the infrastructure is challenging. There needs to be a high degree of prefabrication built in at the design stage so that they can be installed.

Using the ready2grind range, we have developed clients that are not traditional cement producers but rather traders and construction firms. For them, the speed with which the project can be completed is often very important. This is another driver towards a modular, pre-fabricated approach. A further advantage of these systems is that the containerised plant components can be transported and installed more easily. Our 15 references demonstrate that we have also implemented our customers' requirements well in the field of modular systems.

GC: What automation and digitisation features does Gebr. Pfeiffer offer to its clients?

PH: We have followed the Industry 4.0 trend since it became a feature of our sector. It drives our clients and so it drives us. We offer digital 'modules.' Some focus on maintenance, some on enhancing the operation. One of these digital modules is GPLink, which stores sensor data for data analysis. This data can then be transmitted to our service team as a solid support basis for even more rapid and targeted assistance.

GPpro is another one of our digital modules, which facilitates our Advanced Maintenance System. This means that maintenance can be planned and carried out according to actual needs and no longer at fixed intervals. GPpro includes a wider range of sensors as well as a data analysis tool and reports. And we continue to develop this product further and further, thus reacting to the changing requirements of the market.

Another exciting digital topic we are working on is artificial intelligence (AI), because we want to use this technology to optimise mill operations. The benefits of AI are clear. A skilled human operator can certainly set several operating parameters and overlook the interaction of these. With the help of artificial intelligence, you can have any number of



Above: Modular ready2grind systems are installed around the world. Here is an MVR 2500 C-4 in Costa Rica.

parameters examined and always determine the ideal setting values for your application. We see enormous potential here and the first results with an industrial mill have been very promising. Digitisation is progressing and we are following this path.

GC: Does this make the human operator available for other tasks or does it make them obsolete?

PH: The human operator will not become obsolete, but fewer personnel will be needed in the future. We have received more and more requests regarding greater automation due to a number of drivers, even without the coronavirus outbreak. It is clear that the trend is towards greater plant automation in the coming years due to factors like the reduction in skilled workers in the cement sector. If social distancing has to be maintained for many months, or even longer, we may see a need for more automated solutions so that plants can continue to operate without humans coming into close contact with each other.

GC: Could a mill of the future operate with zero staff? If it could, who is responsible for it: The cement producer, the mill manufacturer, the software developer, or the mill itself?

PH: Although Pfeiffer mills are already being operated temporarily with a reduced number of, or even zero, staff, this is a very difficult area that the global community has to answer regarding a number of technologies. Maybe we should ask Elon Musk once he has worked out the answer for driverless cars? Regardless of the eventual answer, I think an 'operator-free mill' 24/7 over a longer time period will not happen any time soon. There will be a need to keep a watchful eye over the technology for some years to come, but we are working on it!

GC: Thank you very much for your thoughts.

PH: You are very welcome.

