Roller press celebrates 40 years

Since its invention 40 years ago, the roller press has continuously improved and expanded its use in the cement and mineral-processing industries. KHD tracks the changes since the technology's introduction and celebrates the advances that have benefitted cement producers during this time.

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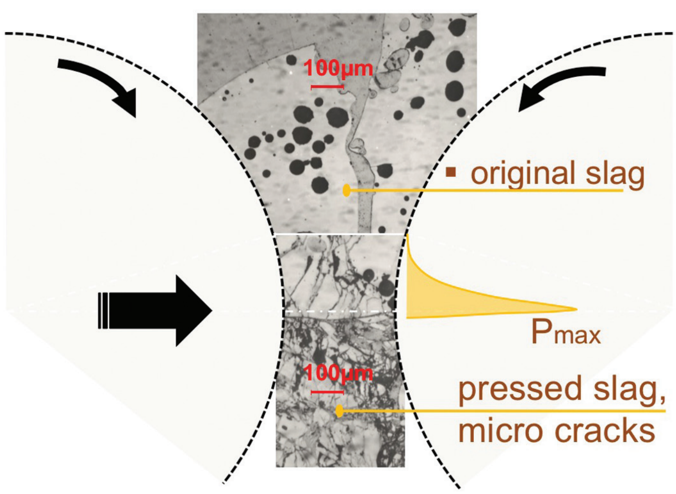
Some four decades ago, the concept of a revolutionary comminution process found its way across the desks of one of Germany's Patent and Trade Mark Offices as a patent application under the title "Method of fine and very fine comminution of materials having brittle behavior". Professor Klaus Schönert was the inventor of this process for the comminution of material with high pressure, which was further developed during the following decades to become the most energy-efficient grinding circuit in the cement and minerals industry. Currently the technology provides energy savings of 50 per cent, and in some cases even more, when compared with traditional grinding systems such as ball mills and up to 20 per cent when compared with vertical roller mills.

Based on the findings of Prof Schönert, KHD Humboldt Wedag GmbH put the world's very first industrial roller press into operation in 1985. Designed for granulated blastfurnace slag (GBS), this roller press remains in operation. However, roller press design has been adapted to grind raw materials, cement and slag as part of a continuous process to improve and extend its use. Today it remains the most cost-efficient comminution method.

Figure 1: the first roller press with a roller diameter of 1m and width of ±60cm

Figure 2: micro-cracks develop in the particles of fresh and treated GBS which decrease the energy required in the next grinding stage



At first: basic research

Basic research into the new comminution technology was carried out at the Technical University of Clausthal Zellerfeld in Germany's Harz mountains where Prof Schönert had a chair in physical processing. Several Master and PhD students conducted fundamental research in high-pressure comminution and prepared the way for the success of the roller press technology.

It was at this point that two equipment suppliers started to design and develop their roller presses. As a result, eight years after the first idea for the patent, the industrial roller press era began with a small press which had a roller diameter of 1m and a width of about 60cm (see Figure 1). Small motors were mounted on the roller press frame and connected to

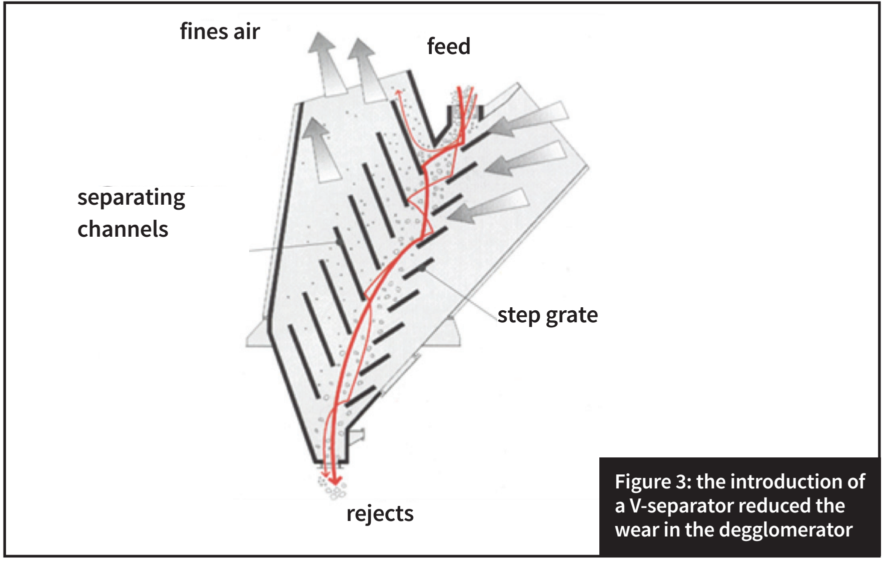


Figure 3: the introduction of a V-separator reduced the wear in the degglomerator

the rollers with V-belts. The small roller dimensions were sufficient to meet the modest capacities required.

KHD started at this time with specific analyses of the comminution behaviour of GBS, a byproduct of the reduction process in raw iron production. The latent hydraulic properties of the finely-ground slag, as well as its low development of heat of hydration during setting, makes GBS cement perfectly suited for massive concrete structures such as foundations and dams. Figure 2 shows microscopic pictures of fresh and treated GBFS which illustrate the formation of several micro-cracks within the particle structure. These decrease the required grinding energy in the next comminution step. At the time of this research by KHD, the second comminution step was often a ball mill. With one or two passings (the process was called slab recirculation) of the slag in the roller press, the new technology results in a >50 per cent energy saving when compared with ball mills.

Developing later generations

Following the successful installation of the first roller press generation in several applications, the need for larger roller diameters developed and KHD introduced its second-generation models with roller press diameters of 1.7m at the start of the 1990s.

Furthermore, the introduction of integrated degglomerators in the company's SKS separators enabled grinding to a higher product fineness. However, the wear in the degglomerator and dynamic separator was high as roller press slabs were very abrasive and difficult to handle. This issue was resolved in the third-generation of roller press grinding circuits in the mid-1990s as a V-separator (see Figure 3) was introduced, which prevented the presence of larger particles that caused wear and degglomeration.To date the static V-separator combines efficient degglomeration and a separation cutpoint in a range of 200-800µm, resulting in a significant step forward in the development of the roller press.

"Modern roller presses also have grinding forces not exceeding the 6N/mm² mark which improves the lifetime of the equipment while delivering the same grinding efficiency."

A further challenge at this time was the limited lifetime of the roller surfaces. High grinding forces of 9-10N/mm² at first and 7N/mm² later led to wear issues that resulted in some reluctance to accept the newcomer in the market. Therefore, different wear protection solutions were developed by different roller press suppliers. KHD's most wear-resistant roller protection is the so-called stud lining (see Figure 4). It features highly wear-resistant tungsten carbide studs inserted into the roller surface, which allows for the formation of a protective autogenous wear layer. GBS is pressed between the studs, covering and protecting more than 70 per cent of the surface. With stud lining, an operation without maintenance of up to 25,000h is possible and a total roller lifetime of more than 40,000h can be expected, even for highly-abrasive material such as slag. Therefore, the specific wear rate of the studs is less than 0.5 g/t.

Today's state-of-the-art roller press circuits

More recent years saw further advances to the roller press, particularly in terms of easy maintenance and grinding force optimisation. For example, the latest generation of KHD roller presses can be opened at the side, enabling the replacement of rollers within 24h.

Modern roller presses also have grinding forces not exceeding the 6N/mm² mark which improves the lifetime of the equipment while delivering the same grinding efficiency.

In addition, the perfect alignment of roller presses in the grinding circuit is a key requirement in their set-up.

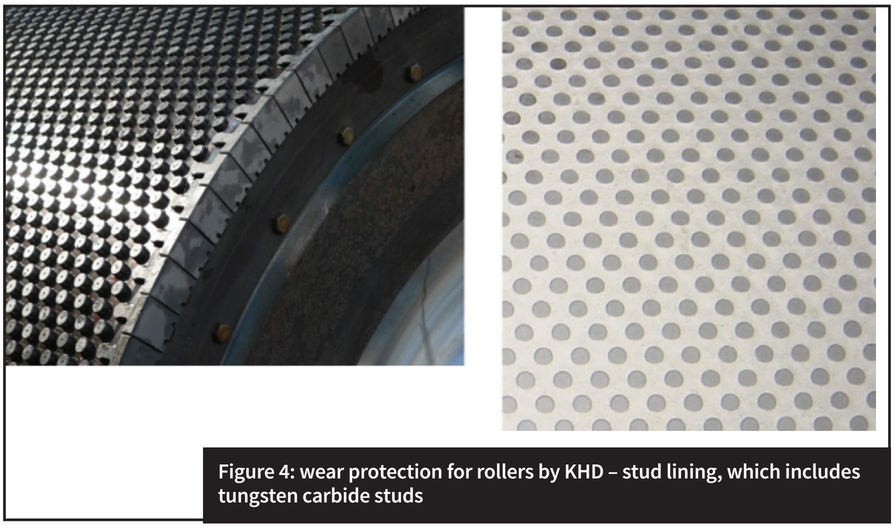


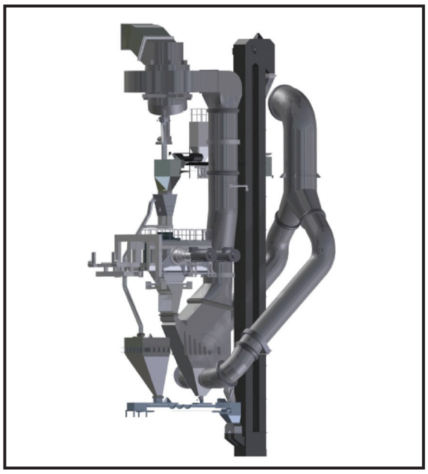
Figure 4: wear protection for rollers by KHD – stud lining, which includes tungsten carbide studs

Figure 5 (below and below right): the design of both grinding solutions features a complete disconnection of separation and grinding to achieve the highest-possible efficiency and enable the treatment of material returned from the separator to the roller press

A static separator such as the V-type separator described previously for degglomeration, drying and coarse separation has become an absolute standard in roller press grinding operations. Furthermore, a dynamic separator for the final cut point, such as the SKS separator by KHD, is needed.

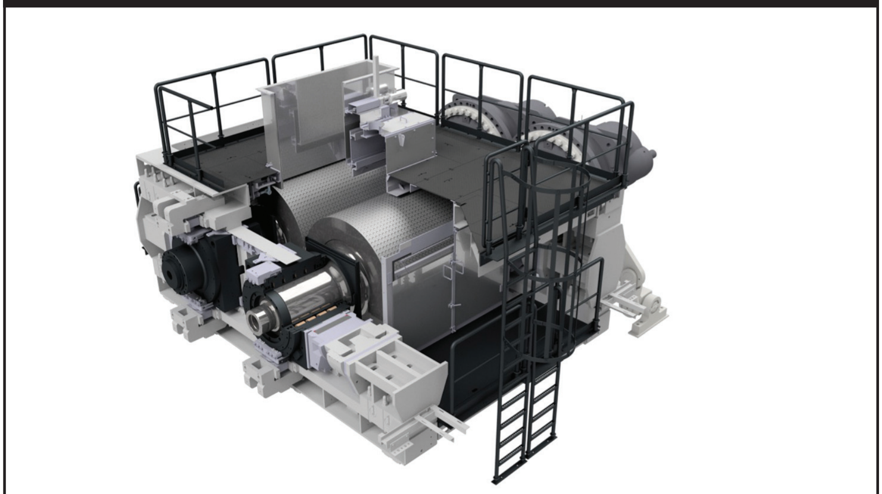
The arrangement of all the required components is a further important requirement in terms of efficient grinding. In 2007 KHD pioneered an energy-efficient and highly-flexible comminution system, using the roller press as the key grinding equipment. COMFLEX® (derived from COMminution and FLEXibility) is the result of continuous development and represents the benchmark of modern roller press technology combining roller press, static and dynamic separator. Furthermore, to lower the building height and reduce the civil cost an additional arrangement has been developed in the last three years. The GrindX® circuit operates without any bucket elevator and an absolute minimum of civil structures. The design of both grinding solutions (see Figure 5) features a complete disconnection of separation and grinding to achieve the highest-possible efficiency and to enable the treatment of return material from separator to the roller press. For example, in slag grinding the extraction of pig iron is essential to reduce wear of the equipment.

In addition to the optimisation of the equipment arrangement the need for larger capacities has recently increased considerably. This resulted in the development of larger grinding systems with high outputs. KHD serves this current market demand with large rollers of up to 2.8m in diameter and press grinding forces



in excess of 30MN. These presses grind about 160tph of slag meal with a fineness of 4200cm^2/g according to Blaine in finish mode (see Figure 6).

Figure 6: to address market demand for larger capacities, KHD has developed roller presses with larger roller diameters (up to 2.8m) and grinding forces surpassing the 30MN mark.



Summary

This year the cement industry celebrates four decades of roller press development. With his idea to comminute brittle material under high pressure, Prof Schönert laid the foundation for the latest-generation grinding systems.

Over the past 30 years, KHD has developed the roller press system to become the most energy-efficient and cost-saving grinding system in the cement world. Slag, raw material, clinker and minerals can be ground in a KHD roller press with stud lining with an absolute minimum of wear and maintenance cost. Incorporated in a COMFLEX® or GrindX® system this roller press represents the benchmark of modern grinding technology and will be established further as the leading finish grinding circuit. ■