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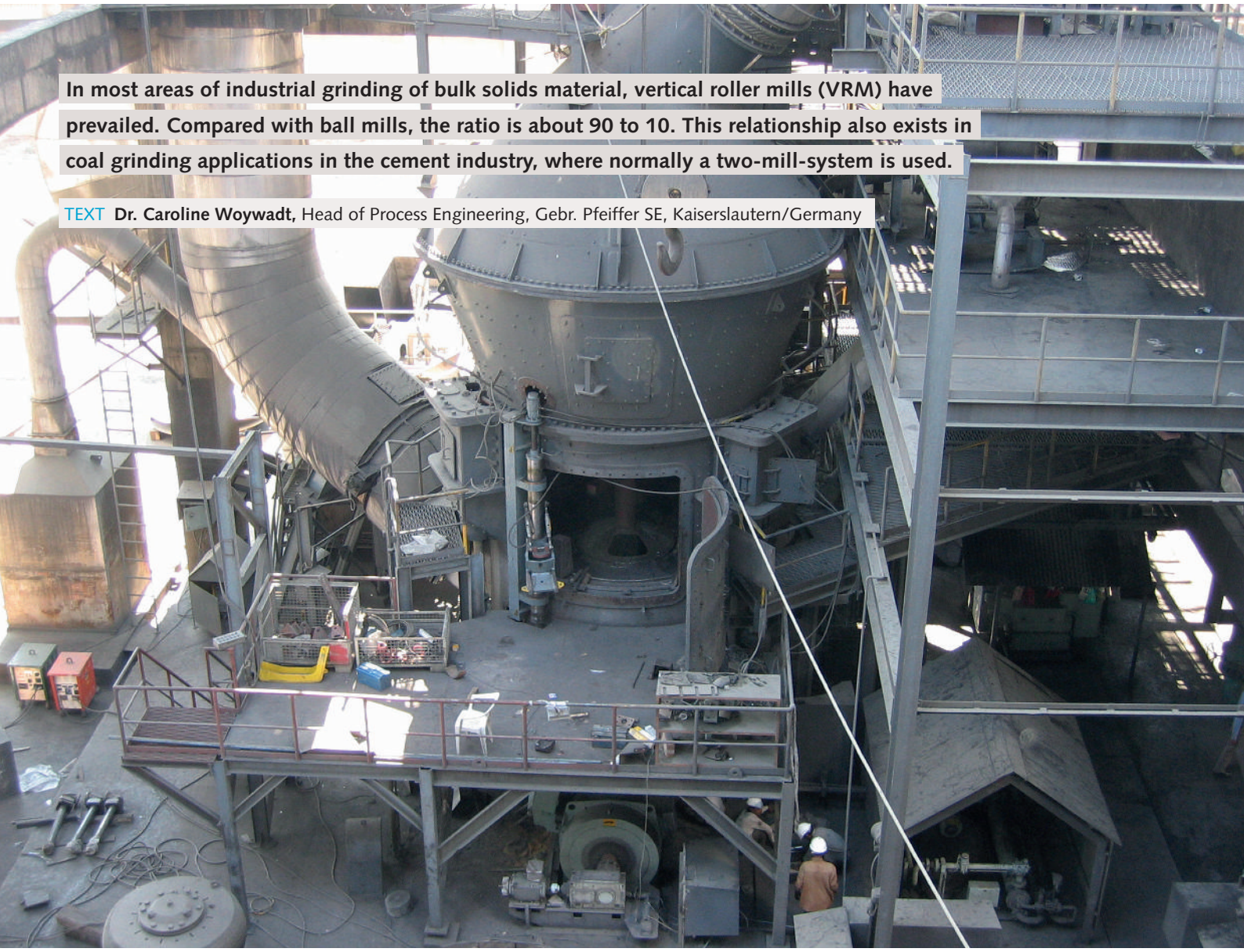

In most areas of industrial grinding of bulk solids material, vertical roller mills (VRM) have prevailed. Compared with ball mills, the ratio is about 90 to 10. This relationship also exists in coal grinding applications in the cement industry, where normally a two-mill-system is used.

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MPS 3070 BK installed in India

GEBR. PFEIFFER SE

MPS mills for coal grinding

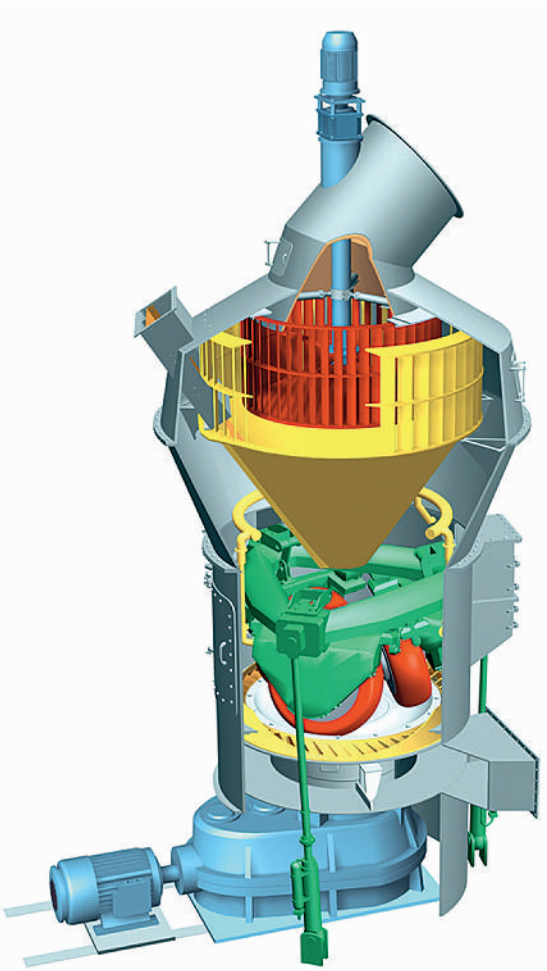
1 Introduction

Two mill systems are employed for most coal grinding applications in the cement industry. These are, on the one hand, vertical roller mills (VRM) that have achieved a share of almost 90 % and, on the other hand, ball mills whose share decreased to just over 10 %.

Gebr. Pfeiffer SE supplies stand-alone MPS coal grinding mills as well as complete coal grinding-drying systems. Both mill and grinding system can be operated under pressure or suction as well as under air or inert gas atmosphere. System configurations cover grinding plants with temporary storage of the pulverized coal in silos (for cement plants, or in blast-furnaces for steel plants, etc.) and installations with direct injection into the combustion system (for power generating plants). For over 40 years, the MPS mills for power stations have been manufactured under license of Hitachi Power Europe GmbH (formerly Babcock Borsig AG), headquartered in Oberhausen, Germany.

2 Design features of MPS mills for coal grinding

Depending on the material to be ground, throughput rates of 5–200 t/h can be achieved in a fineness range between 1 % R0.063 mm and 25 % R0.090 mm. Thus, the MPS coal grinding mill



1 MPS coal grinding mill with SLS high-efficiency classifier

with a high drying capacity is very suitable for grinding lignite with feed moistures of as much as 45 %. Depending on this high feed moisture the mill rating is determined by the drying process whereas for anthracite, hard coal and petcoke the rating of the mill is determined by the grinding process. The great variety of solid fuel properties, such as grindability, ash content, volatiles as well as the required product fineness, calls for a wide range of operating states. The hydropneumatic tension system allows the stepless adjustment of roller force to suit the wide range of solid fuel feed materials. In combination with the adjustable air flow rate the mill control range is between 30 and 100 %. Part-load operation may become necessary as a result of load variations in injection-type grinding mills installed in power plants, changing fuel qualities and a grindability other than that specified in the design criteria for the mill.

The MPS vertical roller mill is characterized by its statically determinate system which consists of the pressure frame, the 3 rollers and the 3 external pull rods and ensures that the load is uniformly distributed to the grinding table. The grinding table is driven via an electric motor and a gearbox. During start-up and maintenance the rollers can be lifted by tensioning cylinders.

A high-efficiency classifier of the type SLS is mounted above the grinding zone. The feeding device for fresh material is arranged in this area where the fresh feed is also mixed with the grits rejected from the classifier (Figure 1). The main difference of an MPS mill for solid fuels to other MPS mills lies in its pressure-shock resistance.

Mill and classifier housing, feed unit and expansion joints are designed to be pressure-shock resistant. To avoid accumulations of coal dust as a source of spontaneous combustion all surfaces in the grinding and classifying zone are vertically oriented or at least steeply inclined.

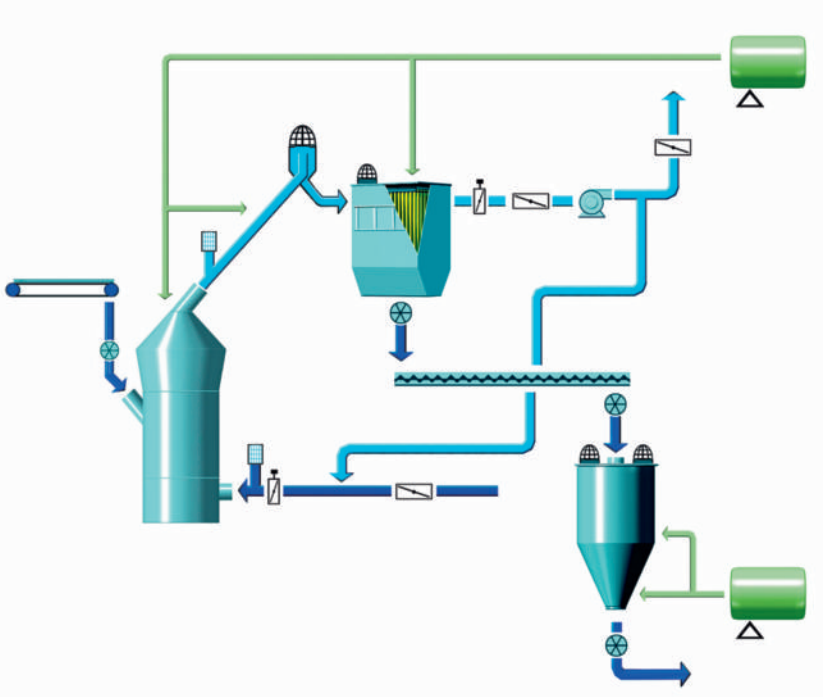
The key features of a coal grinding plant in a cement works are:

- special layout of the plant to avoid coal dust deposits
- pressure-shock resistant design of mill and classifier housing, filter and pulverized coal silos
- use of rapid action flaps, rupture disks and explosion vents in certain parts of the plant
- monitoring of O_2, CO and dust concentration levels in critical places
- supply of CO_2 in the event of safety-relevant limit values being exceeded
- reducing the O_2 concentration level in the dust-laden gases to 8–12 % by using exhaust gas from the rotary kiln, if possible, and by minimizing the amount of false air
- automated linking of all safety-relevant data and process control features of the entire plant

3 Legal basis and plant layout

The European Directive 94/9EG dated 23.04.1994 (ATEX) defines basic health and safety requirements relating to non-electric equipment intended for use in areas with danger of explosion. This applies to the protection of workers against risks

2 Flow sheet



3 Test center GPSE MPS 32-1

arising from the use of equipment and protective systems in potentially explosive atmospheres. The range of member states includes EU-countries, EFTA-countries (e.g. Norway, Switzerland) and countries with special agreements (such as Turkey). The ATEX requirements apply not only to the mill but also to the components supplied along with such as for example rotary feeders or safety dampers. In particular the protective systems, e.g. the quick-acting damper, have to comply with the requirements listed in this directive. The requirements are based on the zone classification specified for the individual plants.

The grinding plant may be operated under non-inert conditions, when grinding low explosive coal types. With non-inert operation exhaust air from the clinker cooler could be used for drying the coal. As a common safety precaution the coal grinding system is operated under inert conditions. This can be achieved by using exhaust gases from the kiln preheater in a cement plant. Figure 2 shows a general plant layout. The coal is fed into the mill through a pressure shock-resistant, self-purifying rotary feeder. After being dried, ground and classified in the mill system, the finished product extracted from the classifier is collected in a bag filter, discharged via screw conveyors and a rotary feeder. The product is then conveyed pneumatically to the coal intermediate silo. Quick-acting dampers are installed in the gas ducts before and after the mill, serving as a safety system in addition to the mill, filter and silo being rendered inert with CO_2. The filter and silos are equipped with pressure relief valves to vent the shock wave and to release possible flames into the atmosphere in case of an explosion. Measurements of CO, O_2 and dust are taken downstream of the filter for monitoring the grinding plant. CO and temperature are monitored in the pulverized coal silo. If the preset limits of CO and O_2 concentration are reached, the safety systems, such as safety dampers, CO_2 inertization of the mill, filter and silo are activated.

4 Rating of MPS mills for coal grinding

The most reliable and comprehensive basis for layout and design is provided by pilot-scale grinding tests of the project-relevant materials. At the GPSE test station, extensive test series with the semi-industrial mill type MPS 40 B (refer to Figure 3) are conducted for the grinding of different solid fuels to determine the basic rating data. With this mill, a pilot plant is available that can be used for the determination of solid fuel material characteristics and project-related data, i.e. specific power consumption, gas volume requirements and specific wear rate. Significant differences occur in material properties and specific

mill performance data between the different solid fuels such as anthracite, hard coal, lignite and petcoke. Even within a single fuel type the deviation is quite high for grindability, ash content, volatiles, moisture and abrasiveness. The layout and design of a grinding system for solid fuels with low to medium moisture contents is generally determined by grinding, whereas the mill rating for lignite with feed moistures of up to 45 % is determined by drying.

An alternative to a grinding test performed in a pilot plant with an MPS 40 B is the well-known Hardgrove grindability procedure (refer to Figure 4). The Hardgrove Index gives less information than a grinding test in a pilot plant provides. The specific wear rate for predicting the lifetime of roller tires can – by performing a Hardgrove Index – only be based on assumptions. The small quantity of material used for the test requires the highest precision during the sampling procedure. Despite all constraints a resilient correlation between Hardgrove indices and MPS mill throughputs has been released for mill rating. Only in lignite grinding a precise design has to be based on a grinding test in the pilot plant.

5 Operating references

More than 1000 MPS mills are in use for grinding various types of solid fuels (lignite to petcoke), including different types of hard coal and anthracite all over the world. Table 1 shows the distribution of MPS mills in different industries exemplarily for the years 1990 to 2013. More than 75 % of them are installed in the cement industry, 20 % in the steel industry and a small part is established in specialized industrial sectors (e.g. zinc melting plant).

	Industry			
Mill size	**Cement**	**Steel**	**Zinc smelting plant**	**Total**
112	2		1	3
125	1			1
140	2		1	3
160	4			4
180	12		1	13
200	9	1	4	14
225	15			15
250	12	5	1	18
2450	1			1
2800	20	2		22
2900		4		4
3070	10	7		17
3350	3	3		6
3550	4			4
3750	1			1
4500	1			1
Total	97	22	8	127

Table 1 MPS mills for solid fuel grinding ordered in the years 1990 to 2013

4 Test center GPSE Hardgrove test unit

5 MPS 250 BK installed in the US

	MPS 200 BK	MPS 225 BK	MPS 3070 BK	MPS 2800 BK	MPS 200 BK	MPS 2800 BK	MPS 3550 BK	MPS 180 K	MPS 30700 BK
	Ukraine	Belgium	India	India	Korea	Jordan	India	Turkey	India
	Refer to **Figure 6**		Refer to **Figure 7**	–					
	Coal/Anthracite	Coal	Petcoke	Coal	Anthracite	Coal	Coal	Petcoke/ lignite	Coal
Throughput rate	21.2 t/h	36.2 t/h	35.1 t/h	48.0 t/h	16.4 t/h	63.0 t/h	80.8 t/h	25.0 t/h	64.0 t/h
Product fineness	10.1 % R0.090 mm	6.7 % R0.090 mm	1.8 % R0.200 mm	9.4 % R0.090 mm	25.0 % R0.090 mm	11.7 % R0.090 mm	14.8 % R0.090 mm	5.6 % R0.090 mm	10.8 % R0.090 mm
Feed moisture	8.4 %	11.4 %	6.3 %	6.0 %	10.0 %	8.0 %	10.0 %	12.0 %	10.3 %
Residue moisture	0.7 %	1.3 %	0.5 %	2.0 %	1.4 %	2.4 %	2.0 %	1.1 %	1.8 %
Spec. power consumption mill	5.7 kWh/t	10.1 kWh/t	18.1 kWh/t	13.1 kWh/t	12.8 kWh/t	8.2 kWh/t	8.2 kWh/t	8.8 kWh/t	10.9 kWh/t

Table 2 Operational data of MPS mills for solid fuel grinding

Over the years the mill sizes ordered have become larger due to changed market requirements. So far, the biggest mill for lignite coal grinding will be delivered to Cemindo's Bayah plant in Indonesia. This MPS 4500 BK has been ordered for grinding lignite with a maximum moisture of 37 % and it is able to produce a throughput rate of minimum 100 t/h at a residue of 15 % R0.09 mm. The installed power for the mill main drive is 1300 kW. The specific energy consumption is set at 11.4 kWh/t for the main mill drive plus the separator rotor drive. Delivery time is 12 months, so the mill will be commissioned in late autumn 2014.

Commissioning of many coal mills is currently in progress.

In the Ukraine an MPS 200 BK for coal grinding was commissioned in early 2013. All performance warranties were fulfilled. The warranties were based on a Hardgrove index of 40, the performance tests were performed with a coal/anthracite mix with a Hardgrove index of about 65

6 MPS 200 BK installed in the Ukraine

which caused a 40 % higher throughput (21.2 t/h vs. 15.0 t/h) at a lower specific energy consumption (6 kWh/t vs. 15 kWh/t).

An MPS 3070 BK installed in India produces 64 t/h of hardcoal with a fineness of 10.8 % R0.090 mm. The hardcoal has a Hardgrove index of 61. The specific wear rate for the roller parts (made of chromium cast alloy) was shown to be nearly 25 g/t.

Petcoke with a Hardgrove index of 35 is ground in an MPS 250 BK (refer to Figure 5). This mill is installed in the US and in operation since 2002. The production rate is 24 t/h with a power consumption of 16.8 kWh/t at a fineness of 5 % R0.090 mm. As second product coal is ground to 8.5 % R0.090 mm with a production rate of 34 t/h and 7.3 kWh/t specific energy consumption for the mill main motor.

These data show the wide range of application for MPS coal grinding mills. Petcokes with low volatile contents need a significantly higher product fineness compared to hard coal and lignites to achieve the optimum burnout performance. Additional figures for different mills are given in Table 2.

6 Conclusion

Consequent development of design and process criteria is an ongoing issue for MPS mills for grinding solid fuels such as coal, anthracite, petcoke and lignite. This is essential to meet the market demands for flexible grinding and drying of a broad range of materials. The vertical roller mill is today the standard solution for any kind of coal grinding installations. With a high reliability, low installation costs and a wide range of sizes, the MPS series provides a proven and economic solution in this regard.

7 MPS 3070 BK installed in India