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SUMMARY

For decades, vertical roller mills have been in use in the cement industry for grinding cement raw material and coal. Since the 1980s this mill type has also been used for combined or separate grinding of cement clinker and additives. In the last two decades the number of installations for grinding cement and blast-furnace slag has increased remarkably. The well-established and proven MPS mills have been used for the combined drying and grinding of cement raw material, coal, cement clinker, blast-furnace slag and composite cements for many years. The trend in the cement industry is towards ever increasing capacities of individual grinding plants. Therefore, the need for high plant availability and an optimized maintenance concept is becoming more and more important. The MVR vertical roller mill with an installed power of up to 12 000 kW is a tailor-made concept to fulfil these requirements. The first MVR mills were installed in Europe for cement raw material and cement grinding. These mills have been in operation since 2007 or 2008 respectively. Meanwhile the worldwide distribution of MVR mills has increased continuously. A large number of MVR mills have been ordered by Indian cement manufacturers. In this contribution, the operating data of several MVR mills installed in India will be discussed in detail.

ZUSAMMENFASSUNG

Vertikal-Rollenmühlen befinden sich in der internationalen Zementindustrie bei der Rohmehlerzeugung und Kohlemahlung seit Jahrzehnten im Einsatz. Seit den 1980er Jahren finden diese Mühlen auch Anwendung für die gemeinsame oder getrennte Mahlung von Zementklinker und Zementadditiven, wobei ihre Zahl in den vergangenen 20 Jahren deutlich zugenommen hat. Dabei wird die gut etablierte MPS-Walzenschüsselmühle bereits seit vielen Jahren zur kombinierten Trocknung und Mahlung von Zementrohmaterialien, zur Kohlestauberzeugung, zur Mahlung von Zementklinkern und Hüttensanden sowie auch zur Herstellung von Zementen mit mehreren Hauptbestandteilen sehr erfolgreich eingesetzt. Da in der internationalen Zementindustrie der Trend zur Vergrößerung der Produktionseinheiten nach dem Einlinienprinzip unvermindert anhält, sind die Forderungen nach einer hohen Anlagenverfügbarkeit bei optimalen Instandhaltungskonzepten auch bei den Mühlen immer wichtiger geworden. Die MVR-Walzenschüsselmühle der Gebr. Pfeiffer SE aus Kaiserslautern erfüllt diese Anforderungen als maßgeschneidertes Mühlenkonzept mit installierten Leistungen für den Antrieb der Mahlschüssel von bis zu 12 000 kW. Die ersten MVR-Mühlen, die für die Rohmehlerzeugung und Zementmahlung in Europa zum Einsatz gelangten, befinden sich seit 2007 bzw. 2008 erfolgreich im Betrieb. In der Zwischenzeit ist ihre Verbreitung kontinuierlich gestiegen. So ist allein die Zahl der MVR-Mühlen, die von indischen Zementherstellern in Auftrag gegeben wurden, ausgesprochen hoch. In dem Beitrag werden die Betriebsdaten der in der indischen Zementindustrie installierten MVR-Mühlen mitgeteilt und im Detail diskutiert.

(English text supplied by the author)

Operation of MVR mills in cement manufacturing – a status report

Der Betrieb von MVR-Mühlen bei der Zementherstellung – ein Statusbericht

1 Introduction

For decades, vertical roller mills have been in use in the cement industry for grinding of raw material and coal. Since the 1980s vertical roller mills have been also used for combined or separate grinding of cement clinker and cement additives. In the last two decades the number of installations for grinding cement or blast-furnace slag has increased remarkably. MPS mills have been used successfully for the combined drying and grinding of cement raw material, coal, cement clinker, blast-furnace slag and composite cements for many years. As a result of the trend for increasing clinker production capacities, the need for high plant availability and an optimized maintenance concept is becoming more and more important. The MVR vertical roller mill from Gebr. Pfeiffer SE is a tailor-made concept to fulfil these requirements.

2 Design features of the MVR roller mill

The design features of the MVR mill differ mainly from the MPS mill in the grinding element geometry, in the roller suspension and the number of rollers. The MVR mill is capable of producing higher output rates of up to 1 000 t/h 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 new MultiDrive® design of the mill drive consisting of up to six identical drive units of up to 2 000 kW each. This feature of the MVR mill is known as active redundancy. All machine parts that are relevant in terms of fluid dynamics, such as hot gas channel, nozzle ring, the so-called SLS high-efficiency classifier and material feed, are of the same design as the parts that have proved successful in the well-established MPS mills.

3 Installations with MVR mills

Over the last years, many MPS and MVR mills have been put into operation all over the world. The first MVR mills were installed in Europe for cement and raw material grinding. These mills have been in operation since 2007 or 2008 respectively. Meanwhile more than 21 MVR mills have been ordered. The map in ◗ Fig. 1 shows the status of the ordered MVR mills. The distribution of MVR mills in India is quite extensive, because ten mills have been ordered by different clients in the cement industry.

Figure 1: MVR mill distribution worldwide

In May 2012 the first MVR mill in India was commissioned at the Balaji plant of Jaiprakash Associates Ltd. In the grinding of Portland pozzolana cement with a dry fly ash content of up to 31 % a throughput rate of 350 t/h at about 4 300 cm²/g Blaine, could be achieved after optimization of the plant. ◗ Table 1 provides operational data on the grinding of Portland fly ash cement. The wet fly ash proportion of 23 % is not the limit of what the grinding-drying system of the mill can handle; in fact, the capacity is restricted by the feeding equipment for wet fly ash. Therefore the client plans to upgrade the feeding equipment for operating the mill with a higher wet fly ash content.

Table 1: Operational data of MVR 5600 C-4 for production of Portland fly ash cement

Designation	Unit	Portland pozzolana cement with a mix of dry and wet fly ash	Portland pozzolana cement with dry fly ash
Clinker	%	63	65
Gypsum	%	5	5
Fly ash, dry	%	10	31
Fly ash, wet	%	23	–
Throughput	t/h	290	350
Fineness acc. to Blaine	cm²/g	4 150	4 300
Spec. power demand (mill, classifier, fan) at shaft	kWh/t	27.6	18.1

An MVR mill for grinding blast-furnace slag and Portland cement was set up in Australia and has been in operation for nearly two years now. Equipped with three drive modules with an installed power of 1 840 kW each and six grinding rollers, the mill with a table diameter of 6 m produces cement and slag meal in accordance with Australian standards.

The so far biggest MVR mill with a table diameter of 6.7 m will be commissioned during the last quarter of 2015 in Brazil. Slag cements with different slag proportions and fineness values will be produced in this mill. Two MVR mills for raw material grinding under erection in the USA and Canada will go on stream in late 2015/early 2016.

PROCESSING

Figure 2: View of the Gebr. Pfeiffer mill MVR 6000 C-6 at the Raipur plant

4 Case study: Shree Cement, India

Since 1995 Gebr. Pfeiffer SE has supplied mills to nearly 50 Indian plants of more than 25 distinguished clients from the Indian cement and steel industry. Shree Cement Ltd. as one key customer has so far ordered a total of 24 mills from Gebr. Pfeiffer SE (19 MPS, 5 MVR mills). The first MVR mill, ordered by Shree, is the 100th Pfeiffer mill for India incorporating all technological developments. Shree has gained operating experience over twenty years with 19 MPS mills for raw material and coal/pet coke grinding. The first units were equipped with the mill types MPS 4750 B for raw material grinding and MPS 250 BK for coal grinding. Further orders were placed almost every year starting from 2004 for the Ras units standing side by side. In each unit an MPS 3750 B mill for cement raw material grinding and an MPS 225 BK for coal/pet coke grinding were installed. The latest Ras units (no. IX and no. X) are each equipped with mills of the designation MPS 5000 B and MPS 2800 BK. For the latest projects Shree decided to install the newly developed MVR mill. In total five MVR mills have been ordered: four MVR 6000 C-6 mills for cement grinding and one MVR 6000 R-6 mill for raw material grinding. The MVR 6000 C-6 mills have been ordered for different locations: Bihar (Aurangabad) grinding unit, Ras New Cement Unit (RNCU) and Bulandshahr unit. With the new integrated Raipur plant (Baloda Bazar) with a cement production capacity of 2.6 million t/a Shree Cement has been diversifying into the central region of India. This plant features an MVR 6000 R-6 mill for raw material grinding and an MVR 6000 C-6 mill for cement grinding (❱ Fig. 2). For coal grinding the well-known Gebr. Pfeiffer mill MPS 2800 BK has been installed. Today for all plants operated by Shree cement the cement production capacity stands at about 24 million t/a.

4.1 Technical concept

The rating of the MVR 6000 R-6 mill was based on grinding tests conducted at Gebr. Pfeiffer's own test station. There are several pilot plants available with MPS and MVR mills which are operated in the same way as industrial plants. These pilot plants are used for the determination of raw material characteristics and project-related data, i.e. specific energy consumption, gas volume requirements, specific wear rate etc. The MVR 6000 R-6 mill at Raipur is designed for a throughput of 500 t/h raw meal at less than 15 % residue on 90 µm equivalent to less than 2 % residue on 212 µm. The grindability determined was poor compared to other raw materials and is characteristic for the Chhattisgarh region, where the plant is located.

The cement grinding mills MVR 6000 C-6 are designed to produce different types of cement and blast-furnace slag meal. Therefore, all dry and wet components such as clinker, gypsum and wet fly ash are fed by belt conveyors through a rota-

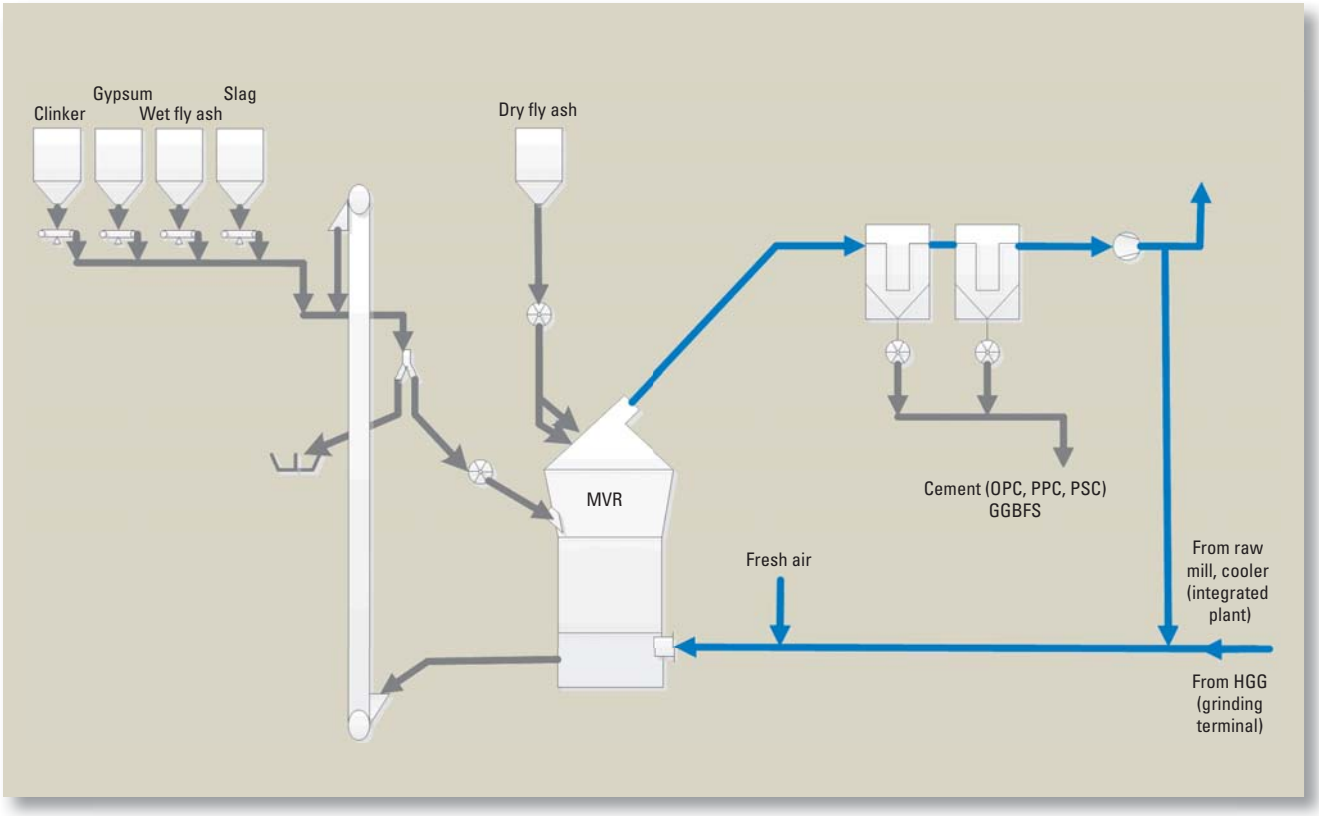

Figure 3: Flow sheet for cement and granulated blast-furnace slag grinding

Figure 4: Feeding points for fly ash at the upper classifier housing

Figure 5: View of the MVR 6000 R-6 mill at the Raipur plant

ry air lock into the mill (◗ Fig. 3). The rotary air lock is heated with hot gas to avoid clogging when feeding a combination of dry and wet components. The dry fly ash is conveyed to an intermediate bin and fed through a rotary valve to one or two feeding points that are located at the upper part of the classifier housing (◗ Fig. 4). The MVR mill is designed for operation with an external material circulation system and is equipped with a water injection system. The finish product is collected in a bag filter and transported via air slides and a bucket elevator to the finish product silos. In the MVR 6000 R-6 mill the finish product is separated differently to the cement grinding plant by a cyclone system which removes more than 90 % of the raw meal. The rest of the raw meal separated in the downstream arranged bag filter is also conveyed via air slides and a bucket elevator to the raw meal silo.

4.2 Technical details and operational data

Technical details for the Gebr. Pfeiffer mills MVR 6000 C-6 and MVR 6000 R-6 are given in ◗ Table 2.

Table 2: Technical details of the Gebr. Pfeiffer mills MVR 6000 C-6 and MVR 6000 R-6

Designation	Unit	MVR 6000 C-6	MVR 6000 R-6
Number of rollers		6	6
Roller diameter	mm	2120	2120
Roller wear part weight	t	6	9
Roller wear part material	–	High chromium alloy cast iron	High chromium alloy cast iron
Installed drive power (planetary drive)	kW	6700	6700
Classifier	–	SLS 5600 BC	SLS 5300 B
Dedusting	–	Bag filter 875000 m³/h (operation), 320 g/m³ (raw dust content), ≤ 20 mg/m³ (stp, dust load, outlet), 12 mbar (pressure drop)	System fan Volume flow design: 1175000 m³/h at 95 °C Pressure drop, design: 98 mbar Installed power: 4500 kW

Table 3: Operational data of cements and slag meal produced in the MVR 6000 C-6 mill

Designation	Unit	OPC	PSC	PPC	GGBFS
Clinker	%	90	46	57	–
Gypsum	%	8	4	5	5
Fly ash, wet/dry	%	2/–	–	7/31	–
GBFS	%	–	50	–	95
Clinker temp.	°C	135	ambient	ambient	–
Feed moisture	%	1.1	6.1	0.8	9.2
Water spray	%	3.1	0	2.7	–
Throughput	t/h	311	235	424	180
Fineness acc. to Blaine	cm²/g	2840	3830	3940	4500
Spec. energy cons. mill	kWh/t	17.7	25.1	13.9	34.0

The plants with the MVR 6000 C-6 mills are designed to produce 270 t/h of OPC with a fineness of 3500 cm²/g Blaine and 270 t/h of PPC at 3800 cm²/g Blaine. Production of a PSC (Portland Slag Cement) and a GGBFS (Ground Granulated Blast-Furnace Slag) is also possible. The Bihar plant is guaranteed to achieve a throughput of 180 t/h of slag meal at a fineness of 4500 cm²/g Blaine.

The MVR 6000 C-6 mills at Ras RNCU and Bihar started operations in early summer 2014. The MVR 6000 C-6 mill for cement grinding at the Raipur plant was com-missioned in March 2015. ◗ Table 3 lists the operational data of Shree Cement Ltd. units producing OPC, PSC and slag meal.

The required throughput rates were achieved in a short time. All fineness figures met the target values without any problems. When grinding compos-ite cements with moist clinker substi-tutes, the combination of drying, grind-ing and separation in one system is advantageous. A smooth and stable mill operation with reduced water spray is possible. Hence grinding without exter-nal heat depends on the feed moisture of the material. The clinker tempera-ture impacts the process conditions. If the temperature is low or ambient the amount of water spray must be lower to fulfil the thermal process balance. With a

higher clinker temperature the amount of water injection or feed moisture can be higher to reduce the mill outlet temperature and finish product temperature. The installation of an external heat source is recommended for a grinding terminal even when production starts with an OPC or PPC with dry fly ash only because wet additives might be used in future.

The MVR 6000 R-6 mill for raw material grinding at the Raipur plant has started operation recently. The plant optimization is in progress; the mill (» Fig. 5) is expected to fulfil all performance guarantees without difficulty.

5 Final remarks

In terms of sustainable development, cement producers must meet versatile requirements; special key concerns are power consumption and plant availability. The new technology of the MVR mill, on the market for eight years now, is a good choice for increased plant availability and ease of maintenance combined with low specific electric and thermal energy consumption. Due to the fact that the lowest investment costs are achieved with single mill solutions for high throughput rates, Gebr. Pfeiffer's clients all over the world have decided in favour of this new technology. ◂