Gebr. Pfeiffer AG

The use of Pfeiffer MPS vertical roller mills in finish-grinding of cements

A case study of Holcim's San Rafael and Merone plants

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Before coming to the main interest of this paper, namely the operating experience with Pfeiffer MPS mills used for finish-grinding of cements in the Holcim plants of San Rafael, Ecuador, and Merone in Italy, some details on the design of the Pfeiffer vertical roller mill:

1. Design of Pfeiffer MPS mill

The Pfeiffer MPS vertical roller mill (fig. 1) features three stationary grinding rollers with a roundish surface, which run in a moulded grinding table driven by an electromotor and a bevel planetary gear-box. The rollers are held in position by a triangular pressure frame to which the pull rods, which transmit the grinding forces into the system, are connected. Three hydraulic cylinder/ nitrogen accumulator combinations are fixed to the pull rods and to the foundation parts on which the mill gearbox is located. This special design allows the rollers of the Pfeiffer mill to move laterally. Depending on the material to be ground, air or hot gases are sucked into the grinding zone through the nozzle ring, which is mounted around the grinding table. The hot gases take the finished product and the near-size particles up to the high-efficiency classifier on top of the mill. Together with the particles, the gases pass through a stationary louver ring and enter the separating zone. The fines are sucked through the rotor that is driven by an electro-mechanical drive and a frequency converter. The fineness of the finished product is determined by the rotation speed of the rotor. Where as the fines leave the classifier, the grits fall back down through the grit cone and onto the centre of the mill. Fresh feed is introduced into the mill through the feed chute, which leads through the grit cone. This design ensures that all grits and the entire feed material are directed to the centre of the mill as this promotes an equal material distribution to all three rollers and an even wear on the rollers. Moreover, jet wear on the mill housing and the pressure yokes of the rollers, caused by course particles in the stream of the gases above the nozzle ring, is reduced. For start-up and shutdown of the mill, the rollers are lifted by the pressure frame.

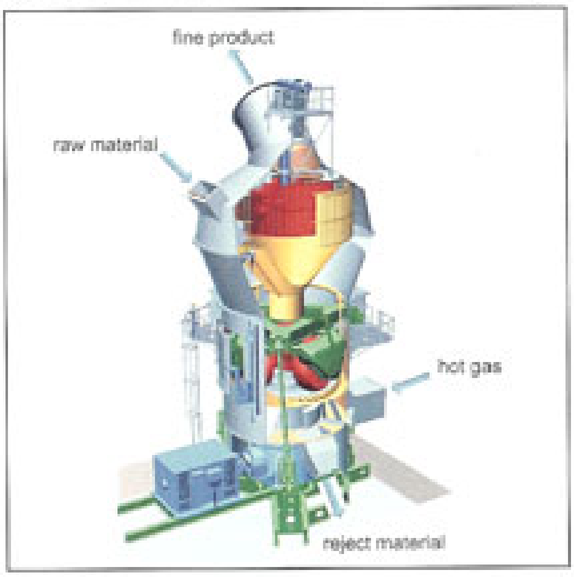

figure 1: design of MPS mill

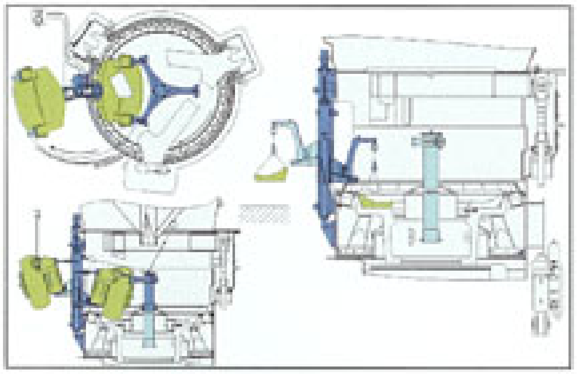

figure 2: Lift-and-Swing System

The Lift-and-Swing system (fig. 2) enables the rollers to be swung out of the mill for maintenance purposes. The same equipment can also be used for changing the liners of the grinding table, which takes very little time - even where large roller mills are concerned. The use of an overhead travelling crane is not necessary. Approximately 35 hours are required for changing the liners on all three rollers and

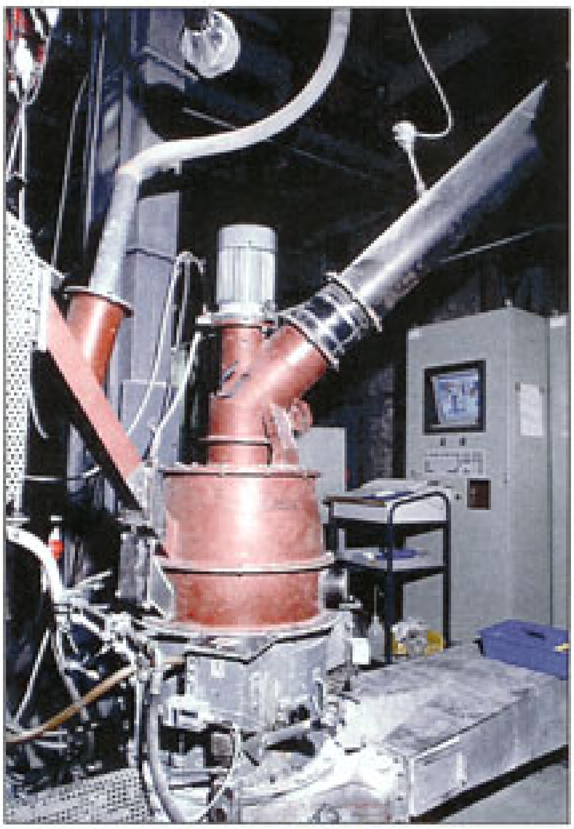

figure 3: test mill

the table liners of medium-size mills.

In the case of highly abrasive materials being processed and cement and blast furnace slag being ground, Gebr. Pfeiffer AG recommends hardsurfacing the table and roller liners, which can be done inside the mill. If the procedure is to be carried out on larger size mills, three torches are used for hardsurfacing the grinding table and one torch for each roller.

2. Grinding tests

To facilitate the sizing of raw mills and also of cement and slag mills, it is advisable to conduct a grinding test on the materials to be processed. If the customer intends to grind cement, these grinding tests also ascertain the cement qualities for the client (fig. 3).

3. History of finish-grinding in vertical mills

The first industrial vertical mill for grinding cements was commissioned by Pfeiffer at Teutonia Cement, Hanover, in 1980 (fig. 4). The mill produces rapid-hardening Portland cement and mainly slag cements with slag contents of up to 80 %. Nowadays, Pfeiffer mills with table diameters between 2 and 5 m are in operation worldwide. The throughput rates of mills used for cement finish grinding vary from 10 to 120 t/h, and the throughput of a mill for the semi-finish grinding of clinker, blast furnace slag and pozzolana amounts to 300 t/h.

figure 4: MPS 3750 C, 1980

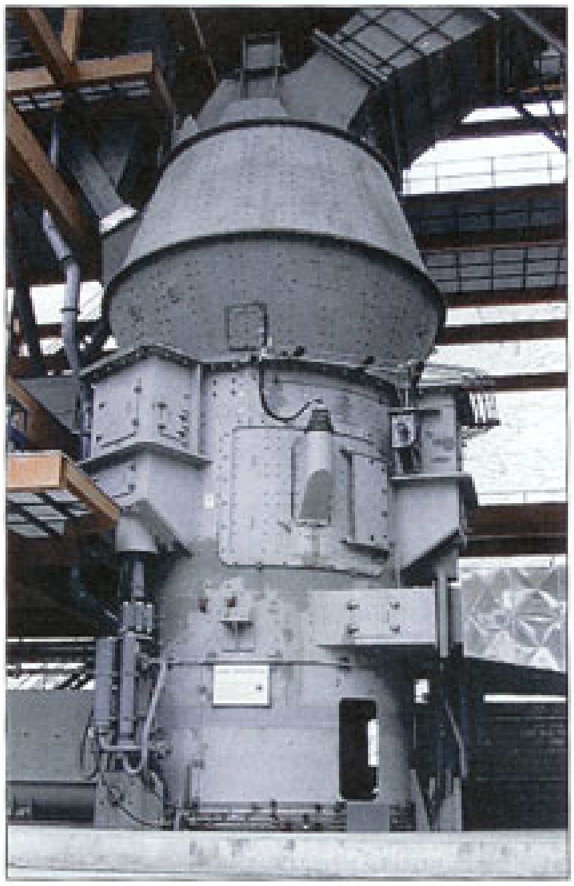

figure 5: MPS 4250 BC, Latacunga, 2002

4. The MPS 4250 BC at the San Rafael/ Latacunga plant

The San Rafael grinding plant of Industrias Rocacem (fig. 5), whose major shareholder is Holcim, is located in Latacunga in the Andes, around 100 km south of Quito. At altitude of 2800 m above sea level, the plant is situated directly in a pozzolana deposit. Clinker and gypsum are supplied by the Guayaquil-based Cerro Blanco plant, where a Pfeiffer MPS 5300 B roller mill and a Pfeiffer 225 BK coal mill are running. The Latacunga mill, an MPS 4250 BC, was warranted to produce a throughput of 110 t/h at a residue of max 4 % R 0.045 mm when used for intergrinding 65 % clinker, 30 % pozzolana and 5 % gypsum (fig. 6).

The basic design of this plant is the same as that of various other plants used through-out the world for grinding cement, pozzolana or blast furnace slag. The raw materials are discharged from the storage bins, proportioned by weigh feeders and dropped onto a belt conveyor. Before the material enters the mill, it is cleared of metal by a magnetic separator and a metal detector which controls a change-over flap. The material enters the Pfeiffer mill through a rotary air lock. The roller mill grinds, dries and separates the material. The hot gas used for drying the material is produced by a hot gas generator and drawn through the mill by a variable speed mill fan. The finished product is collected in cyclones and a bag filter before being

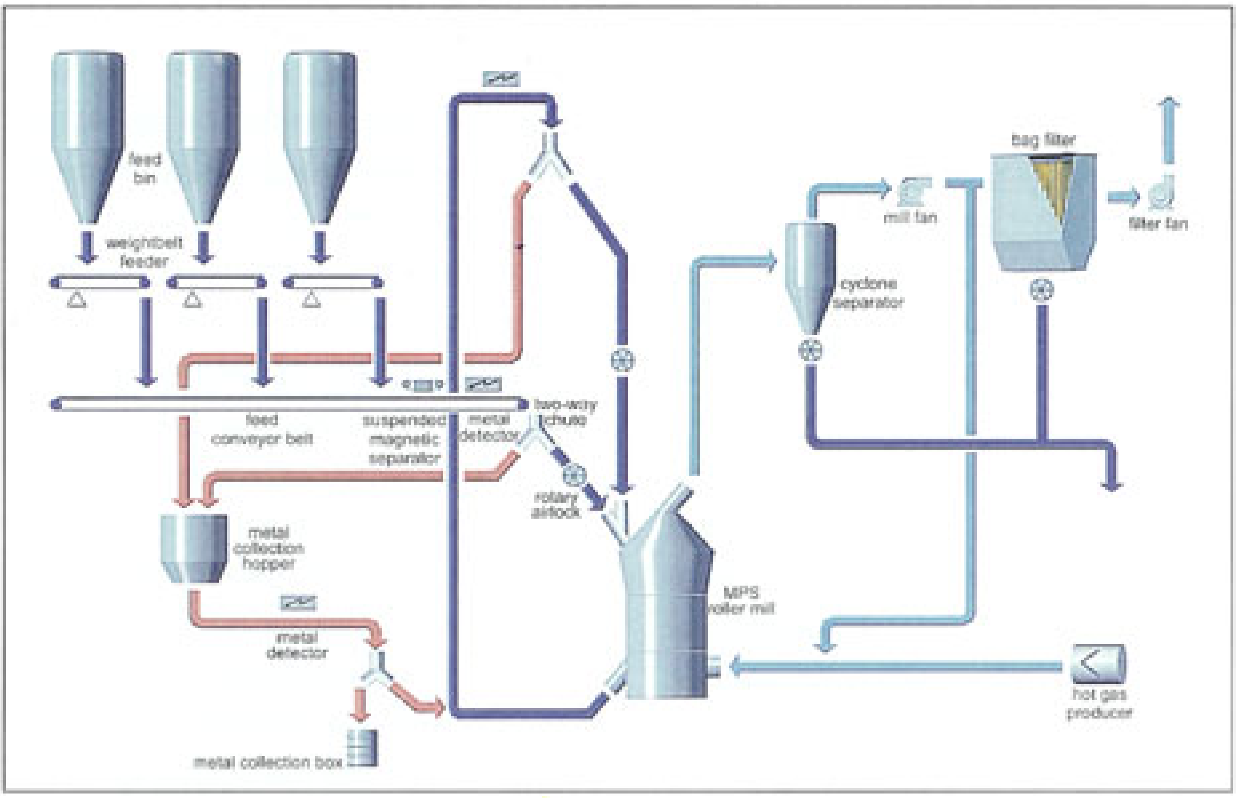

figure 6: flow sheet Latacunga

conveyed to the cement silos by air slides and a bucket elevator. The mill is equipped with an external material circulation system which reduces the pressure loss. This external material circulation system has an intermediate bin, which is also used for emptying the mill and the belt conveyors for maintenance reasons.

After a design and erection phase of 18 months the plant was started up in December 2001. During initial operation, the mill ran with a mixture of clinker, pozzolana and gypsum with a pozzolana rate of less than 10 %. A throughput of over 100 t was achieved, the fineness of the finish product exceeding 4000 Blaine. Later on, the pozzolana content was raised to the guaranteed 25 %, and the output increased to 118 t/h. The product fineness met the guaranteed figures, both in terms of residue and specific surface. Since February 2002 the plant has been operating without assistance. The pozzolanic cement produced complies with the Ecuadorian standards INEN 490 and ASTM C 595 and satisfies the market requirements in all respects. In the acceptance test performed in April 2002 the throughput was even 7 % higher than guaranteed, and the specific power consumption of the plant was 15 % lower. This high level of performance has since been maintained in day-to-day operation (fig. 7).

	unit	achieved	warranted
clinker	%	67	65
pozzolana	%	30	30
gypsum	%	3	5
feed moisture content	%	3.2	5.7
fineness, R 0.045 mm	%	3.8	4
output	tph	118	110
spec. power requirement mill, separator, fan	kWh/t	28	33.2

figure 7: operating data Latacunga

5. The MPS 4250 BC at the Merone plant

The Holcim Merone plant is situated near the northern Italian village of Merone, close to Lake Como, around 100 km north of Milan (fig. 8). While the Latacunga plant was tailored for grinding one cement quality, the Merone plant is suitable for grinding a wide range of different mixed cements. Three different cements were

figure 8: MPS 4250 BC, Merone, 2004

guaranteed (see fig. 9). The concept of the plant is similar to that of the Latacunga plant, the main difference being that, due to blast furnace slag being ground, the mill is equipped with two feed chutes, one for the clinker and the other for the additives. A magnet separator and a metal detector are integrated into the fresh material feed system. The mill plant is provided with an external material circulation system. As slag is being ground, the external material circulation system is equipped with another magnet separator for removing pig iron from the system, which reduces the specific wear rate significantly. The raw materials are supplied from existing plant parts via conveyor belts and distributed to several silos. The finished product that leaves the classifier is directly collected in a bag filter. The gas stream is generated by a variable speed fan located downstream of the bag filter. Hot gases are produced by a hot gas generator upstream of the mill. The finished product is taken to the existing pneumatic transporting system by a bucket elevator and air slides.

cement type		CEM 32.5 II BM	CEM 42.5 I	CEM III B
clinker	%	69.2	89.3	29.5
gypsum	%	5.7	5.7	5.5
slag	%	12.5	-	65.0
limestone	%	12.5	5.0	-
output	tph	120	100	75
spec. power requirement mill	kWh/t	16.5	20.0	27.0
spec. power requirement mill, separator, fan	kWh/t	28.2	33.6	45.0
spec. surface Sm (Blaine)	cm²/g	4000	3800	4000

figure 9: guarantee data Merone

Given that the grinding station had to be integrated into an existing plant, very limited space was available, which called for an extremely compact design. Existing equipment had to be bypassed. The plant was successfully commissioned in July 2004, roughly fourteen months after the signing of the contract. CEM 32.5 II BM cement is currently being produced (fig. 10). The fact that merely 400 litres of water per hour are sprayed into the mill is particularly noteworthy, this quantity being extremely low compared to other mills in operation.

Since the Merone mill went on stream, the client has been satisfied with the cement produced by the Pfeiffer MPS, and the product is being sold successfully to the end users.

The first hardsurfacing of the grinding elements is scheduled to take place in the low-production period of the plant, that is in October/ November. Depending on the mix of the different cements to be ground, rewelding is planned to be carried out every twelve months.

6. Conclusion

The two examples described above show that the Pfeiffer MPS mills are a reliable choice for grinding Portland cement as well as mixed cements. Our customers' satisfaction reflects the benefits of using MPS mills for the production of customised mixed cements. Among other projects, Pfeiffer is currently executing contracts for the biggest slag mill in the world for Tenghui Cement, China. With an installed power of 5300 kW, the MPS 5600 BC mill will be capable of grinding 170 t/h to a fineness of 4000 Blaine. Furthermore, Pfeiffer is processing orders from its Iranian clients Tehran Cement and Hegmatan Cement for 4 MPS 4250 BC mills.

CEM 32,5 II BM		achieved	warranted
clinker	%	64.0	69.2
gypsum	%	6.0	5.7
slag	%	18.0	12.6
limestone	%	7.0	12.5
pozzolana	%	6.0	-
water spray into mill	m^3/h	0.4	2.5
output	tph	126	120
spec. power requirement mill	kWh/t	13.6	16.5
spec. power requirement mill, separator, fan	kWh/t	25.4	28.2
spec. surface Sm (Blaine)	cm^2/g	4400	4000

figure 10: operating data Merone