

MPS VERTICAL ROLLER MILLS FOR GYPSUM

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- GG** Gebr. Pfeiffer AG supplies MPS vertical roller mills, ball mills and molculator mills, separators and kettles to the gypsum industry. The specific power consumption at the mill drive for grinding natural gypsum ranges from 2.5 to 5.5 kWh/t, which means it is relatively low, both for grinding-drying and grinding-calcining.
- GG** Gebr. Pfeiffer AG fournit au secteur du gypse des broyeurs à galets MPS/à cylindre vertical, des broyeurs à billes, des séparateurs et des chaudières. La consommation d'électricité spécifique du moteur du broyeur pour le broyage de gypse naturel est comprise entre 2,5 et 5,5 kWh par tonne, ce qui est relativement bas, pour les opérations de broyage-assèchement et de broyage-calcination.
- GG** Die Gebr. Pfeiffer AG beliefert die Gipsindustrie mit MPS-Walzenschüsselmühlen, Kugelmühlen, Sichtern und Gipskochern. Der spezifische Energieverbrauch für den Mühlenantrieb zur Vermahlung von Naturgips liegt zwischen 2,5 und 5,5 kWh/t, was sowohl für die Mahltrocknung als auch die Mahlkalkzinierung einen relativ niedrigen Energieverbrauch darstellt.
- GG** Gebr. Pfeiffer AG abastece al sector del yeso con molinos verticales de rodillos MPS, molinos de bolas, separadores y calderas. El consumo de energía específico del sistema de accionamiento del molino para moler yeso natural oscila entre los 2,5 y 5,5 kWh/t, lo que resulta relativamente bajo, tanto para la trituración y el secado como para la trituración y el calcinado.

Gebr. Pfeiffer AG is a medium-sized privately-owned company supplying solutions for the fields of grinding, separating, drying, calcining and hydrating, and it has been in operation for more than 130 years. The company employs approximately 250 people and has its own workshop facilities in Kaiserslautern, about 100km from Frankfurt in Germany. The company's annual turnover is in between Euro40-60m. The clients and projects are situated worldwide and are mainly to be found in the cement, lime, gypsum and ceramic industries.

Gebr. Pfeiffer AG supplies MPS vertical roller mills, ball mills and molculator mills, separators and kettles to the gypsum industry. The scope of supply ranges from individual machines to semi-turnkey plants worth more than Euro10m.

Operating principle

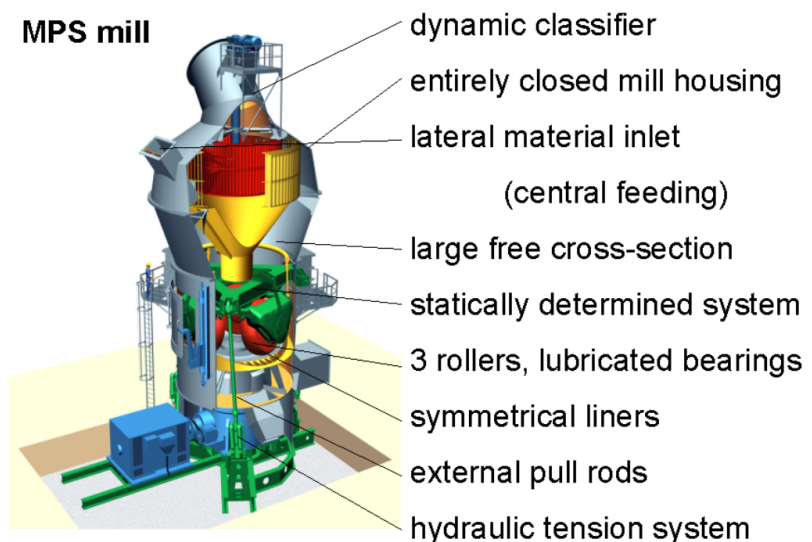
The basic operating principle of the MPS vertical roller mill is shown in Figure 1. The feed is ground between the three stationary grinding rollers and the rotating grinding table by compression and shear. The compression force required for the comminution is generated by a hydropneumatic tension system.

The material is ground and conveyed towards the stationary air-ported ring by centrifugal force. Hot gases flowing up through the air-ported ring mix with the material and create a fluidised bed, where the drying and/or calcining process takes place. Fine material is carried up to the classifier by the gases. The material is

divided into fine product and grits in the separating zone near the rotating classifier wheel. The grits fall back into the centre of the grinding zone. The finished product leaves the classifier together with the gas stream and is separated from the gas in a downstream filter unit. With modern MPS mills, the rollers are lifted during start-up, which simplifies the starting procedure and reduces the necessary starting torque. An auxiliary drive for starting purposes is therefore no longer needed.

This basic principle is the same for all MPS mills, but the applications vary. In the cement industry, mills with installed drive powers from 1000kW up to more than 5000kW are used for grinding raw material and cement or blast furnace slag, producing more than 500t/h of cement

Figure 1: Basic layout of the MPS roller mill.



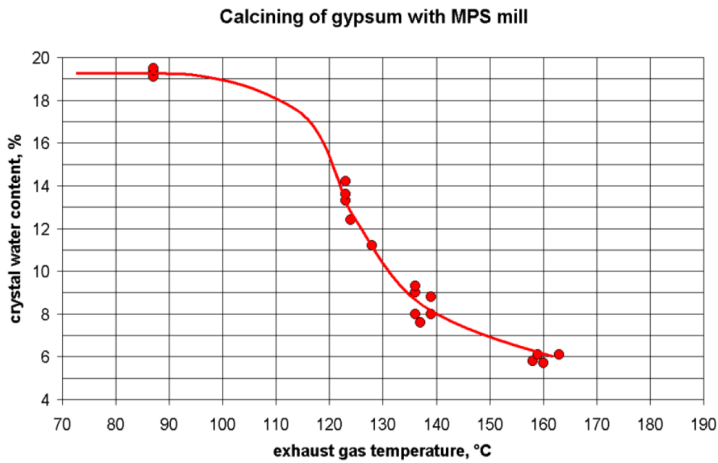


Figure 2: Exhaust gas temperature vs crystal water content.

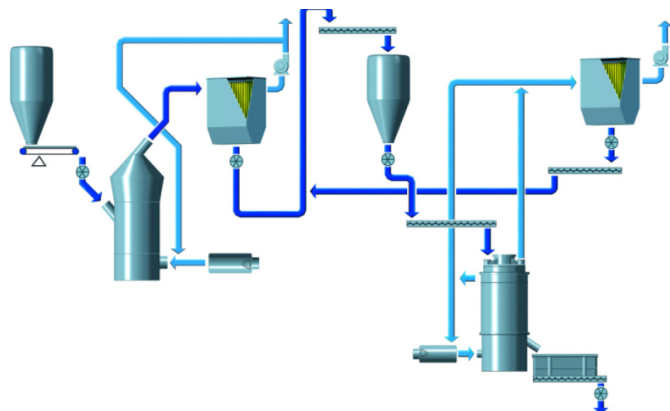
raw material and over 100t/h of cement or blast furnace slag. MPS mills with drive powers of up to 355kW and capacities of about 60t/h are meanwhile operating in the gypsum industry. This reflects the current needs of the gypsum market. Projects involving grinding-calculating mills with capacities of up to 100t/h are in progress at present.

Flow sheet

The applications of the MPS mill in the gypsum industry range from grinding-drying to grinding-calculating. This results from the close relation between the classifier exhaust gas temperature and the residual crystal water (Figure 2).

Grinding-drying, with or without pre-calculating taking place, e.g to reduce the crystal water content to between 12 and 15%, is often carried out before the material enters the kettles (Figure 3) or other downstream calcination units. A project involving a plant like the one illustrated in this flowsheet is presently under contract. The plant is intended for processing 600t/d of gypsum, mainly for wall plaster. One 180 B MPS vertical roller mill is used for grinding-drying and pre-calculating natural gypsum to reduce the crystal water content to 13%. The final calcining stage takes place in two Gebr. Pfeiffer AG GK 300 A kettles. Gebr. Pfeiffer AG will supply

Figure 3: Grinding-drying taking place before gypsum enters the calcining kettles.

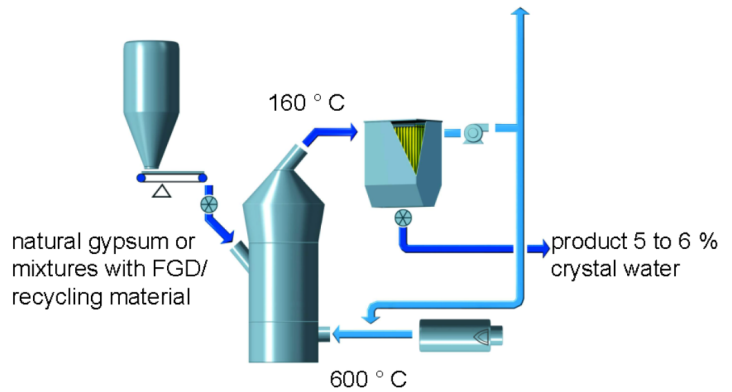


the whole plant, including crushing, grinding-calculating, storage, packing and diesel power station, on a semi-turnkey basis. The plant will start operation in 2004.

By increasing the classifier exhaust gas temperature of the MPS mill to about 160°C, the product is calcined to a crystal water content of approximately 5 to 6%.

The process type illustrated in the grinding-calculating flowsheet (Figure 4) is frequent practice in plasterboard plants. Here Gebr. Pfeiffer AG works in close cooperation with Grenzebach-BSH. The largest MPS presently used for calcining is an MPS 2500 GC designed for a throughput of 60t/h. Current projects comprise mills such as the MPS 3070 GC with a capacity as high as 100t/h. A comparison with larger-sized mills used in the cement industry shows that these limits are not due to the mill concept but to the actual needs of the customers.

Figure 4: Flowsheet for an MPS mill used in a grinding-calculating application.



For grinding natural gypsum, irrespective of whether a certain FGD gypsum or recycling material content is included, the specific power consumption at the mill drive ranges from 2.5 to 5.5 kWh/t, which means that it is relatively low, both for grinding-drying and grinding-calculating processes. In connection with the grinding-drying of natural gypsum in MPS mills, this leads to dust loads in a range between 800 and 1000g/m³ downstream of the classifier, which is higher than what is usually obtained when grinding cement raw material or coal. The mills of the MPS B series are designed for a temperature level of up to 450°C upstream of the mill and a maximum of 130°C downstream of the classifier.

The thermal energy input required for grinding-calculating is considerably higher. The temperature level is increased to 600°C upstream of the grinding-calculating mills of the MPS GC series with a view to an economical scale in terms of mill size.

The amount of recirculated gas is limited to about 60% by the water introduced with the gypsum, the burner exhaust gases and the false air. The dust load downstream of the classifier is below 300g/m³ due to the heat and gas balance. A variable speed mill drive is a standard feature with the MPS GC-series to main-

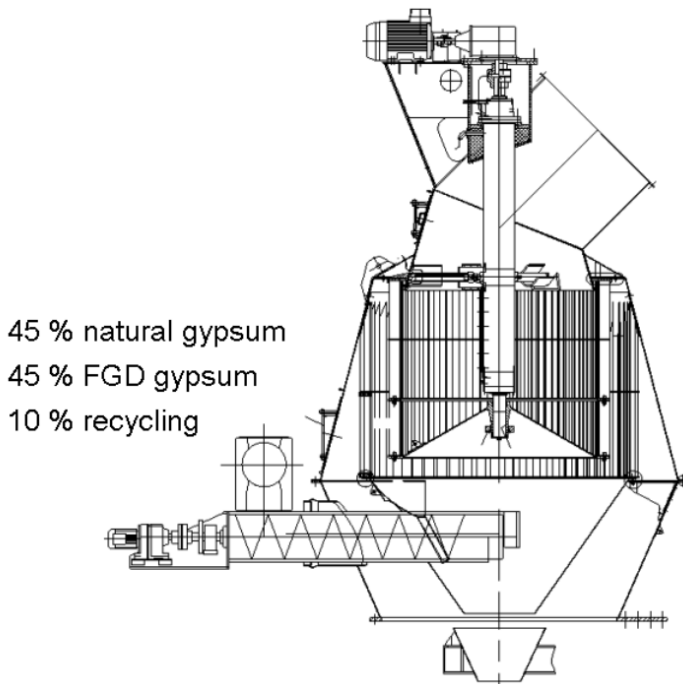


Figure 5: The 60t/h MPS 2500 GC grinding-calcining mill, designed for up to 45% FGD gypsum, includes a special rotary feeder and double-shaft screw conveyor.

tain the balance between the mechanical grinding and the exact thermal calcining with a view to ensuring a stable production at all times, that is if feed parameters change or during start-up.

It is not possible to grind 100% FGD gypsum with a typical maximum size of 200 microns in a vertical roller mill, since no stable grinding bed between rollers and table can be obtained. If, however, 40% of natural gypsum, perhaps a percentage below that, is included, the MPS vertical roller mill is capable of processing FGD gypsum and recycled material. In such cases the desired product particle size is even more important than usual: The question is whether the FGD gypsum only has to be dried or calcined in the mill or whether it also needs to be ground. In the latter case the FGD gypsum has to be included in the grinding bed, which changes the behaviour of the grinding bed. This aspect must be taken into account in the design of the grinding system.

Moreover, the clogging behaviour of wet FGD gypsum has to be taken into consideration when choosing the conveying and mill feeding devices. For the 60t/h MPS 2500 GC grinding-calcining mill, designed for up to 45% of FGD gypsum, a special rotary feeder together with a double-shaft screw conveyor was selected (Figure 5). This takes the feed directly to the centre of the mill.

Machine design

Increasing the hot gas temperature before the mill from about 450°C to 600°C has many implications for the physical properties required of the steel. For example the creep rupture strength for breakage of a 15 Mo 3 steel drops from 298N/mm² at 450°C to 71N/mm² at

550°C after 10,000 hours, that is to less than 25%¹.

For the MPS-mills of the GC series, this general phenomenon leads to several changes in the machine design, especially in the area of the hot gas channel, the grinding table, the air-ported ring and the bearings of the rollers and the high efficiency classifier (Figure 6). The hot gas channel comes with a layered thermal insulation on the inside to protect the outer housing. It is also designed for ease of replacement thanks to the flanges provided.

When calcining gypsum or drying very moist materials, the grinding table is subject to much higher thermal stresses than those resulting from the grinding itself. The potential shown in FEM calculations is consequently used to reduce the thermal stresses by geometrical changes (Figure 7). The level of the maximum equivalent stress is reduced significantly by optimising the design in this way. The table is also protected by a heat shield and thermal insulation.

The use of segmented table liners and a segmented air guide cone represent further measures to reduce the impact of the heat. The air-ported ring is equipped with flexible suspension components to allow thermal expansion without exposing other mill parts to stress.

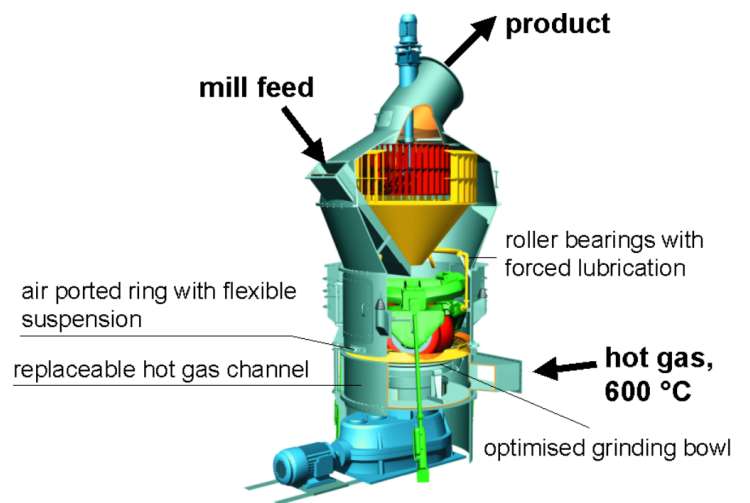
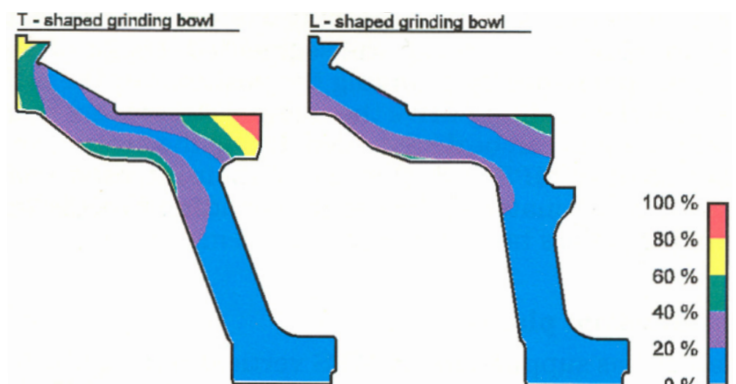


Figure 6: Modifications required for the MPS GC gypsum calcination mills.

Figure 7: When calcining gypsum, the grinding table is subject to high thermal stresses. FEM calculations are used to reduce the thermal stresses by geometrical changes.



As the calcination process takes place in the fluidised bed just above the air-ported ring, the temperature level above this area is about 160°C, similar to the temperature of the classifier exhaust gases. The grinding table, including heat protection and liners, therefore has to be designed to cope with thermal stresses caused by the temperature difference of 600°C on the hot gas channel side and 160°C in the grinding bed during steady-state operation. During cold start at full capacity, the temperature difference and the thermal stresses in the grinding table are much higher as the upper side of the grinding table is still cold, which may cause cracks. To prevent damage on the grinding table, a start-up procedure has to be followed to warm up the mill (Figure 8).

This consists of a preheating period without production and a limited rate production which is then raised to the full capacity. The length of the period depends on the mill size and the length of the stoppage. No warm-up is needed if the mill is stopped for less than four hours.

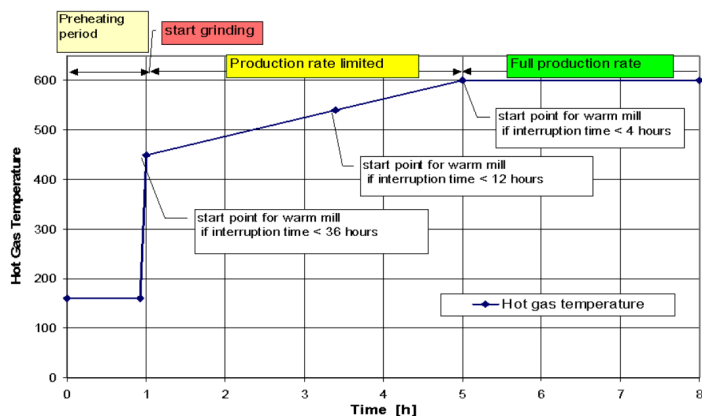
The bearings of the three rollers and the high-efficiency classifier of MPS GC calcining mills are located in the zone where the temperature is 160°C, although they are all designed for permanent operation at 180°C. The forced lubrication of the grinding roller bearings with oil cooling and filtering outside the mill instead of splash lubrication of the grinding-drying mills of the MPS B series is a standard feature with the GC series.

Operating data

Table 1 illustrates the difference in the operation of MPS mills for grinding-drying and grinding-calcining. Although the grindability is in the same range, the smaller MPS 125 A with a grinding track diameter of 1.25m has a capacity of about 40t/h when grinding drying natural gypsum or mixtures with FGD gypsum. The larger-sized MPS 140 GC mills with 1.4m grinding tracks produce approximately 25t/h of ground and calcined product containing less than 6% of residual crystal water. Some additional data of MPS grinding-calcining plants currently in operation can be seen in Table 2.

The capacity ranges from 4 to 60t/h with temperatures of up to 600°C upstream of the mill and about 160°C downstream of the classifier outlet duct. The MPS 2500 GC has been operated with natural gypsum so far, but it

Figure 8: The mill must be warmed-up carefully.



	grinding-drying		grinding-calcining	
commissioned	1989	1994	2000	2001
country	Germany		Brasil	Mexico
MPS	125 A	125 A	140 GC	140 GC
table / mm	1600	1600	1800	1800
drive / kW	160	200	132	160
throughput / t/h	40	42	25	27
t before mill / °C	130	350	600	510
t after mill / °C	60	75	158	159
dustload / g/m³	800	930	290	330
grindability / kWh/t	4.0	3.1	4.4	3.9

Table 1, above, and Table 2, below.

commissioned	2000	2001	2001	2002
country	Brasil	Mexico	Kasachstan	Poland
MPS	140 GC	140 GC	80 GC	2500 GC
table / mm	1800	1800	900	2500
drive / kW	132	160	30	355
throughput / t/h	25	26	4.4	54
t before mill / °C	600	510	390	420
t after mill / °C	158	159	163	160
setting time / min		5/15	7.5/-	5.5/12.5
grindability / kWh/t	4.4	3.9	3.9	3.5

is also suitable for processing a maximum of 45% of FGD gypsum and 10% of recycling material.

Conclusion

In the gypsum industry MPS vertical roller mills are used for grinding-drying and grinding-calcining of natural gypsum or mixtures of natural gypsum, FGD gypsum and recycling material.

The main features are:

- No limitation in terms of capacity and current production rates reach up to 60t/h in connection with grinding-calcining;
- Natural gypsum or mixtures with FGD gypsum, recycling material;
- Start with lifted rollers, no metal-to-metal contact;
- Lubricated roller bearings with splash or forced lubrication, no metal-to-metal contact;
- Easily replaceable liners;
- High efficiency classifier;
- Calcining mills (MPS GC series) also feature;
- Optimised design in view of thermal stresses;
- Segmented components for the high temperature area;
- Easy replacement of parts exposed to high temperatures thanks to flanged design.

References

[1] C.W. Wegst: Key to steel 2001, Verlag Stahlschlüssel Wegst GmbH, Marbach.
 [2] O. Jung, K.-H. Schütte: Thermal stress in vertical roller mills when grinding very moist materials, ZKG International, 51. Vol. (1998), No. 8, pp. 438-443.