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The MultiDrive® – a safeguard against total failure

Der MultiDrive® – Sicherheit gegen Totalausfall

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SUMMARY

Over the past years the continuous trend towards ever larger production units has led to the development of the MVR vertical roller mill at Gebr. Pfeiffer and, in this connection, to the development of the MultiDrive® system in cooperation with Siemens. This has consequently raised the potential of the MVR mill with respect to performance, reliability and availability. The running times that have now been achieved with completed plants and the satisfaction of the customers confirm the correctness of the chosen drive system. Value analysis of the system led very recently to further optimization of the CAPEX costs and underlines the position of the MultiDrive® as a tested and proven drive system that protects the client against total failure.

ZUSAMMENFASSUNG

Der anhaltende Trend zu immer größeren Produktionseinheiten führte bei Gebr. Pfeiffer in den vergangenen Jahren zur Entwicklung der so genannten MVR-Walzenschüsselmühle und in diesem Zusammenhang in Kooperation mit Siemens zur Entwicklung des MultiDrive®-Konzepts, welches das Potenzial der MVR-Mühle in Bezug auf Leistungsfähigkeit, Ausfallsicherheit und Verfügbarkeit folgerichtig steigert. Die inzwischen erzielten Laufzeiten bei realisierten Anlagen sowie die Zufriedenheit der Kunden bestätigen die Richtigkeit des gewählten Antriebskonzepts. Eine wertanalytische Untersuchung des Konzepts führte jüngst zu einer weiteren Optimierung der CAPEX-Kosten und unterstreicht die Position des MultiDrive® als erprobtes und bewährtes Antriebskonzept, das den Kunden vor dem Totalausfall schützt.

(Translation by Robin B.C. Baker)

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1 Introduction

The MultiDrive® drive system that has proved successful in practice since 2009 was developed by Gebr. Pfeiffer in conjunction with Siemens/Flender specifically for driving the MVR vertical roller mill (◗ Fig. 1). Unlike virtually any other mill drive system the MultiDrive offers maximum availability and therefore provides the greatest possible security against possible total failure (◗ Fig. 2). The mill is driven through a girth gear flanged to the grinding bowl by up to six actively redundant drive units with a total output of up to 18000 kW (◗ Fig. 3), each consisting of an electric motor, coupling and gear unit. The use of this drive system means that the gear units are not exposed to the grinding forces (◗ Fig. 4). Thanks to the electrical and mechanical redundancy the mill can continue to run even in the unlikely event of the failure of a drive unit.

Driving the MVR vertical roller mill with a MultiDrive® represents a crucial step forward not just because of the opportunity for transmitting high drive ratings. The MVR vertical roller mill equipped with the MultiDrive® drive system is still available for operation even if a roller has to be taken out of the grinding process. The advantages are no unplanned stoppages and a very high production capacity at all times. The installation of just one mill achieves availabilities and outputs that would otherwise require two vertical roller mills set up in parallel.

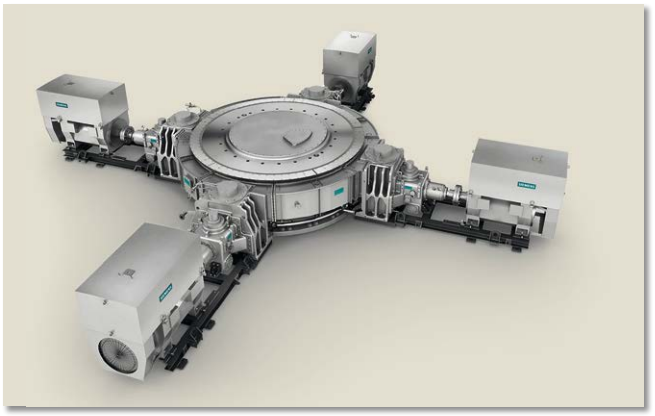


Figure 1: The MultiDrive® drive system, shown with four individual drives

Figure 2: Active redundancy: C130 "Hercules" over Kaiserslautern

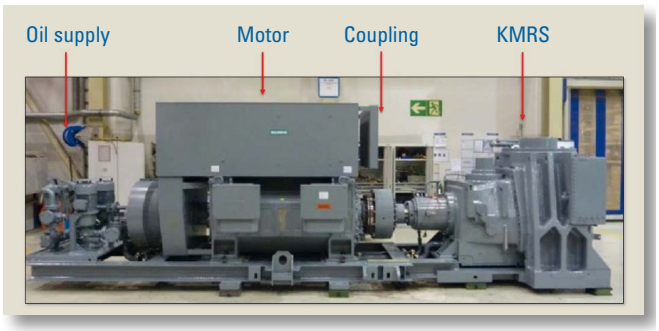


Figure 3: MultiDrive® drive unit consisting of KMRS 2200 gear unit, coupling, electric motor and oil supply system

2 Completed plants, tests and operating results

Since their introduction in 2009 [1] the MVR mills equipped with the MultiDrive® drive system have been submitted to tests and extensive operating experience has been gathered.

- A pilot plant equipped with a MultiDrive with three drive units in an MPS 4750 BC vertical roller mill was commissioned in 2009 in a cement plant belonging to HolcimLafarge in France.
- This pilot plant and the subsequent operational plants (◗ Table 1) were submitted to intensive testing.
- The tests and analyses led to ongoing improvements to the MultiDrive® drive system.

Table 1: Completed MultiDrive® drives

Customer	Project, country	Mill type	Drive rating [kW]	Status
Holcim	"Val de Seine", FRA	MPS 4750 BC	3 x 1450 = 4350	in operation
Jaypee	"Balaji". IND	MVR 5600 C-4	4 x 1650 = 6600	in operation
HolcimLafarge	"Port Kembla", AUS	MVR 6000 C-6	3 x 1917 = 5750	in operation
HolcimLafarge	"Barroso", BRA	MVR 6700 C-6	6 x 1927 = 11500	in operation
HolcimLafarge	"Biskra", DZA	MVR 6700 C-6	5 x 1825 = 9125	in operation
Chip Mong Insee Cement	"Touk Meas", KHM	MVR 6000 C-6	4 x 1800 = 7200	being delivered
Cherat Cement	"Cherat", PAK	MVR 6300 C-6	4 x 1950 = 7800	being processed

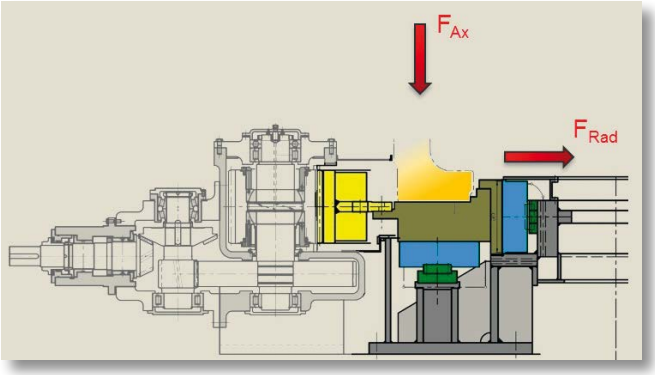


Figure 4: Dispersion of the axial and radial forces

- At the same time a modular MultiDrive® construction system was developed with different sizes of grinding bowl support systems.
- There are now five MultiDrive drives in operation with variable speed adjustment and one MultiDrive drive with fixed speed is being delivered. So far 31 KMRS 220 gear units were built.
- The MultiDrive® drive system is an alternative drive system for vertical roller mills that now combines long-term operating experience with great operating results.

The drive system was systematically improved against the background of the experience that had been obtained. The operating experience and test results are described below using three examples of different mill sizes.

2.1 MPS 4750 BC vertical roller mill at Val de Seine, France

The mill is driven through a MultiDrive® drive system equipped with three drives with a total installed rating of 4350 kW.

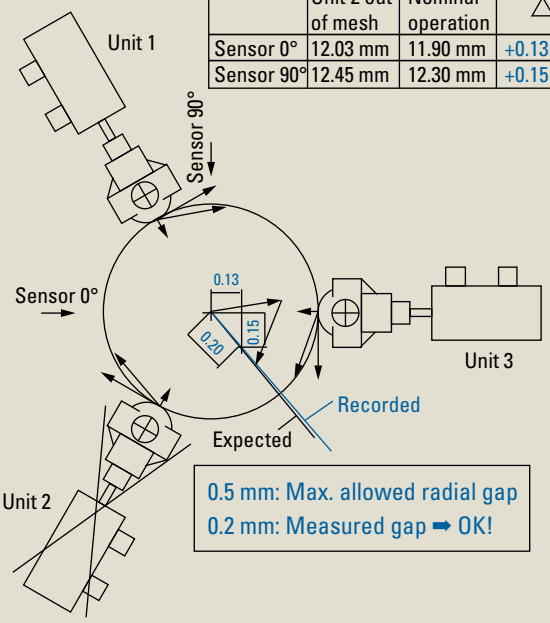
Investigation

The mill was operated for several days with (n-1) drives during which the displacement of the drive flange was measured.

Successfully tested over several days consecutively with one drive unit taken out of mesh

Extent and direction of the recorded displacement from the centre due to radial forces were below the expected range

	Unit 2 out of mesh	Nominal operation	△
Sensor 0°	12.03 mm	11.90 mm	+0.13mm
Sensor 90°	12.45 mm	12.30 mm	+0.15 mm



Design proven by operation!

Figure 5: Results with (n-1) drives for an MPS vertical roller mill in Val de Seine

Results

- The direction of displacement was established as assumed and a smaller displacement than expected was measured (❱ Fig. 5).
- There were no problems with continuous operation in this operating state.
- From stopping the mill to re-starting it the time taken for disengaging a drive was 8 h.

Roller force -> Grinding bowl

Displacement of output flange

Runout:

- stat.: Girth gear is pushed 0.3 mm in the expected direction
- dyn.: Fluctuation margin unchanged

Wobble 4-1:

- stat.: Grinding bowl lifts 0.6 mm below the raised roller
- dyn.: Fluctuation margin unchanged

Wobble 1-2:

- stat.: 90° to the raised roller grinding bowl lifts 0.3 mm
- dyn.: Fluctuation margin unchanged

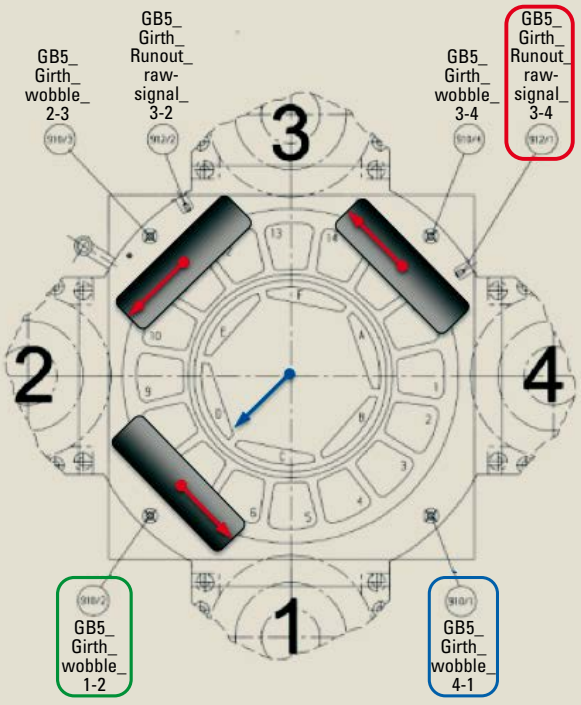


Figure 6: Results from operation with (n-1) rollers at Balaji

2.2 MVR 5600 C-4 vertical roller mill in Balaji, India

The mill is driven through a MultiDrive® drive system consisting of four drives with a total installed rating of 6600 kW.

Investigation

The mill was operated with (n-1) rollers. The roller was raised and secured. Various measurements were carried out during the operation with (n-1) rollers.

Results

- Operation with (n-1) rollers was, as expected, possible.
- Apart from the output the process engineering parameters were unchanged. The output achieved was 85 %.
- The fluctuations in power consumption, rotational speed, current input and measured torque were higher than during the operation with all rollers. The torque fluctuations, for example, rose from ± 10 to ± 20 %.
- The smoothness of running proved to be practically unchanged.
- The displacement of the drive flange of the grinding bowl support system was as expected (▸ Fig. 6).
- No abnormalities were detected in the pad bearing pressures, e.g. pressure irregularities due to bearing displacement.
- There were no problems with continuous operation in this operating state.

2.3 MVR 6700 C-6 vertical roller mill at Barroso, Brazil

The "Barroso" MVR 6700 C-6 vertical roller mill in Brazil is the most powerful vertical roller mill in operation that is used for grinding cement. The mill is driven by a MultiDrive® drive system with six drives with a total installed rating of 11 500 kW. The MultiDrive® is equipped with frequency converters that allow the grinding bowl speed to be adjusted to suit the different product grades.

Since April 2016 the mill has been in operation to the complete satisfaction of the operator, who reported in a lecture in December 2016 in Fort Lauderdale on the remarkable quietness of running of the MVR mill [2] and emphasized the flexibility of the plant that makes it possible to produce a wide variety of types of cement. The progress of the commissioning of the grinding plant was also described as very satisfactory so that after only 79 operating hours the mill could be operated without the presence of a GP supervisor.

The capital investments costs (CAPEX) for the new cement production line in the cement plant belonging to the HolcimLafarge Group were reduced by about 25 % through the use of the MVR mill with MultiDrive®.

3 The MultiDrive® against the background of specific customer demands

3.1 Demands based on the example of large cement mills (> 9000 kW)

According to Harder [3], vertical roller mills with installed drive ratings of up to 5000 kW lie in the small to medium power range, mills with drive ratings of 5000 to 9000 kW are classified as large mills and above this are very large mills.

In projects where the mills have drive ratings > 9000 kW the standard for mill suppliers has been set very high: high outputs with reduced production costs and increased efficiency with the ability to produce different blended cements under conditions of comparatively low total investment. In addition to this it is necessary to fulfil the demands for very high plant availability and sophisticated maintenance schemes so that the cost per tonne of cement produced can be kept permanently at a fairly low level. Today's customers favour the one-line principle to fulfil the requirement for low total investment, but only on the condition that total failure of cement production can be ruled out by guaranteeing excellent availability of the grinding system.

The total drive power of 11 500 kW needed to obtain an output of 450 t/h in the example of the "Barroso" mill cannot be achieved with conventional drive systems. Gebr. Pfeiffer is now in the position to offer the most suitable drive solution for this and comparable requirements at the lowest possible CAPEX costs.

3.2 Advantages of the MultiDrive® multiple drive system

The customers' demands can be met individually through carefully developed and well engineered strategies so that the MultiDrive® drive system combines the following advantages:

Table 2: ROI base on the example of a 270 t/h mill (MVR 6000 C-6)

	6 Rollers in operation 0 under maintenance	5 Rollers in operation 1 under maintenance	Sales per day (24 hrs)		Losses
MVR with MultiDrive®	**[t/h] (100 %)**	**[t/h] (84 %)**	**US$ (100 %)**	**US$ (84 %)**	**US$ (after 5 days)**
CEM II 42,5	270	227	388 800	326 592	311 040
	3 Rollers in operation 0 under maintenance	**2 Rollers in operation** 1 under maintenance	**Sales per day (24 h)**		**Losses**
VRM with conventional gear unit	**[t/h] (100 %)**	**[t/h] (0 %)**	**US$ (100 %)**	**US$ (0 %)**	**US$ (after 5 days)**
CEM II 42,5	270	0	388 800	–	1 944 000
Estimated downtime for maintenance work		5 days			
Working hours cement mill per day		24 hours			
Estimated price for 1 tonne of various cement types		US$ 60			

Modularity

- 2, 3, 4, 5 or 6 identical drive units, each consisting of motor, coupling and gear unit, drive the girth gear of the grinding bowl support system with a total installed rating of up to 18000 kW.
- KMRS 2200 and KMRS 2540 gear units are used in the drive units.

Engineering

- Patented innovative solutions.
- Drive of the grinding bowl with variable or constant rotational speed.
- The MultiDrive® drive system represents a successful solution for driving the MVR vertical roller mill and the use of space-saving twin supports means that there are also appropriate lanes for removing the grinding bowl support system.
- The radial bearing using pivoted shoe technology is dimensioned to take dynamic radial forces from the grinding operation as well as static radial forces from operation with (n-1) rollers and (n-1) drives.

Active redundancy

The MultiDrive® drive system increases the MVR vertical roller mill's great potential. Operation of the mill with (n-1) rollers and (n-1) drives was verified successfully during the test operation.

The MVR vertical roller mill has a high degree of mechanical and electrical redundancy and, in contrast to mills and drive systems in which the failure of a single component leads to a production stoppage, can maintain production operation.

Space- and cost-saving design

The use of the MultiDrive® drive system facilitates the lowest overall height of all the mill drive systems on the market and means that the MVR grinding plants can be built very compactly and economically.

The grinding forces act on the base with a small lever arm and are directed conveniently into the foundation.

Flexible through variable grinding speed

The MultiDrive® drive system can, if required, be operated at varying speeds using frequency converters. In many cases it is possible to dispense with the speed control but a frequency converter can be retrofitted at any time if the requirements change.

Simple maintenance

The drive units are positioned radially on mounts so they are easy to pull out from under the mill and can then be picked up with a crane. With a maximum weight of 25 t per KMRS-2200 drive unit this ensures comparatively greater ease of maintenance.

Efficient stock-holding

The stock-holding is simpler and more economical due to the simple modular design based entirely on standard components. A drive unit can also be used in other mills that are driven by a MultiDrive® drive system.

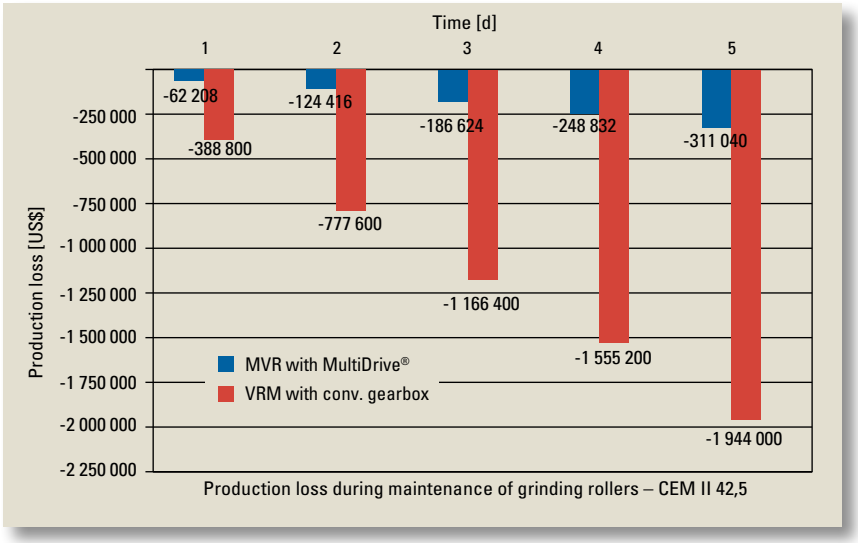


Figure 7: ROI based on the example of a 270 t/h MVR 6000 C-6 mill

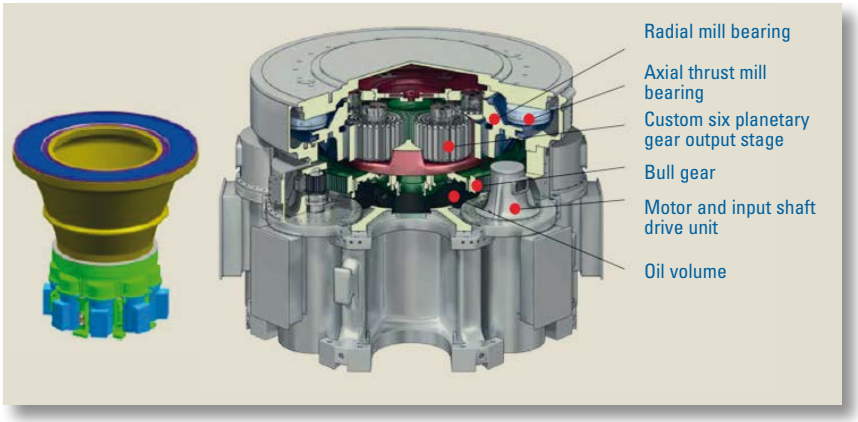


Figure 8: COPE drive with grinding bowl [4, 5]

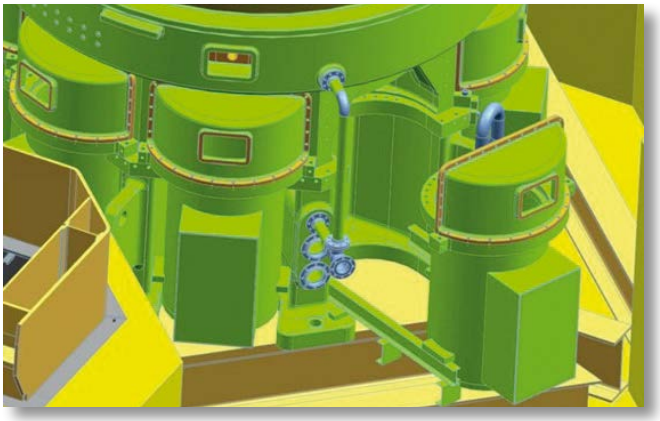


Figure 9: COPE drive with one motor removed [6]

Optimum plant profitability (ROI, TCO)

Unlike any other mill drive system, unplanned stoppage times are reduced to a minimum. Even with unplanned stops the one-mill solution using an MVR vertical roller mill, when compared with a two-mill solution, gives a better rate of return in the long term thanks to its high level of availability.

Costs/ROI

An examination of costs shows that the use of the MVR vertical roller mill equipped with the MultiDrive® drive system

Figure 10: Motor accessibility with the MultiDrive® drive system

is also characterized by a favourable cost/benefit ratio. This is shown in ◗ Table 2 and ◗ Fig. 7 based on the example of an MVR cement mill with six rollers and an output of 270 t/h when compared with a mill of the same capacity with three grinding rollers. If one of the six rollers in the MVR mill has to be taken out of operation for maintenance reasons the output falls to 84 %. If, with the other mill with three rollers, one roller is taken out of operation then the mill can no longer be operated – the output drops to zero. With a basic cement price of 60 US$/t and an assumed outage time of five days there is a loss of sales revenue with the MVR mill equipped with the MultiDrive® drive system of about 300000 US$. For the competitor mill it is almost 2000000 US$.

4 Differentiation from other drive systems

In conventional mill drives the gear unit not only transmits the power from the motor to the grinding bowl but also carries the grinding forces down into the foundation. The MultiDrive® drive system is currently the only drive solution on the market that separates these two processes. The advantage is that there is no additional loading by axial and radial grinding forces.

Harder [3] also counts the COPE drive from Renk [4] among the multiple drives. The COPE-Drive builds up high and slim, so that it can pass through the narrow gap between the single supports (◗ Fig. 8). With the comparatively clean MultiDrive®-concept, there are not many single components under the mill where the access is very difficult, so that with the MultiDrive® it is, for example, simpler to remove a motor (◗ Figs. 9 and 10).

A robust and flat grinding bowl support system is used for the MVR grinding bowl through the use of space-saving twin supports as there is sufficient space for its installation and removal. This grinding bowl support system is capable of taking static radial forces from the operation of the mill with (n-1) rollers and (n-1) drives (see Fig. 4). Dynamic radial forces amounting to 30 % of the axial force are also taken in accordance with the customer's design criteria.

The advantages of driving the MVR vertical roller mill with a MultiDrive® were verified in tests on operating plants. Even with very large production units a level of availability never previously obtained is achieved through the active redundancy of the mill and MultiDrive®. Apart from the comparatively favourable total investment cost the implementation of the one-mill technology is therefore very important for the grinding plants in both the raw meal and cement departments. ◗ Figs. 11 and 12 show the MultiDrive® drive system in the cement mills at HolcimLafarge's Biskra and Barroso cement plants.

Figure 11: View of the drive situation for the MVR 6700 C-6 vertical roller mill at Biskra

Figure 12: View of the drive situation for the MVR 6700 C-6 vertical roller mill at Barroso

5 Outlook

An MVR vertical roller mill, driven by a MultiDrive® with four drives, is currently being delivered to a cement plant in Cambodia and a mill driven by a MultiDrive® with four variable-speed drives is being processed for a customer in Pakistan. Not only the advantages with the OPEX costs but also optimized CAPEX costs have become apparent now that the MultiDrive® drive system has been examined from the value analysis point of view. ◂

LITERATURE

[1] Hoffmann, D.; Reichardt, Y.; Schütte, K.-H.: The MVR vertical roller mill plus MultiDrive® a successful combination. CEMENT INTERNATIONAL 9 (2011) No. 2, pp. 44–19.

[2] HolcimLafarge-Vortrag auf dem "Gebr. Pfeiffer ready-2grind Technical Panel", Fort Lauderdale, Dec 2016.

[3] Harder, J.: Drives for large vertical roller mills. ZKG International (2017) No. 1/2, pp. 32–39.

[4] Broschure of Renk about the COPE-Drive, edition 02.2015.

[5] XXXI Congresso Tecnico FICEM. Federacion Interamericana del Cemento, Santo Domingo, Republica Dominicana, 2014.

[6] 19th Arab International Cement Conferenz and Exhibition, November 2014.