A holistic VRM approach

The quadropol® vertical roller mill by thyssenkrupp Industrial Solutions takes a holistic approach to modern grinding systems in terms of its simple and compatible design. Describing the key concepts behind the technology, the company shares notable project experiences and results from Cementos Progreso's new plant in Guatemala and Yamama Cement's two new 10,000tpd kiln lines in Saudi Arabia.

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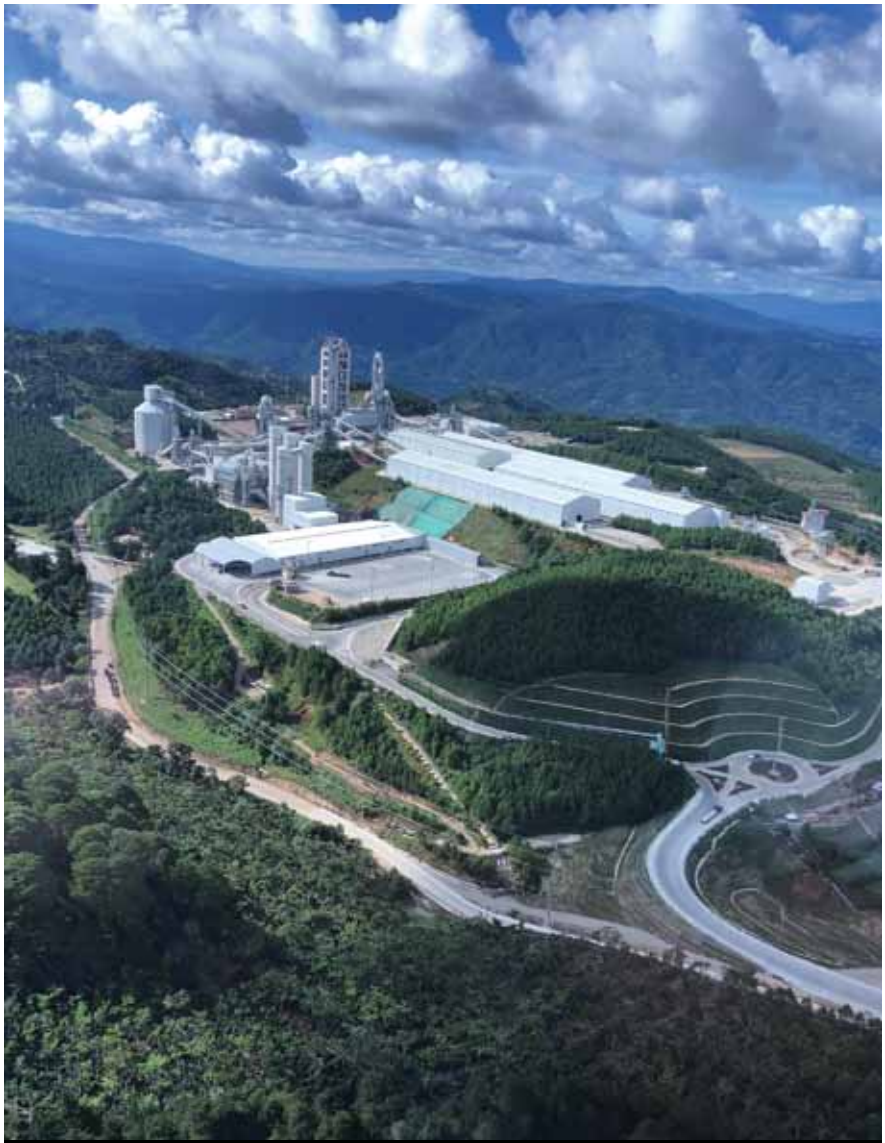
Put simply and briefly, thyssenkrupp's quadropol® vertical roller mill (VRM) remains one of the leading VRMs in the market in terms of its simple and compatible design structure. Requirements by plant operators for a reliable solution, as well as not requiring tie rods to introduce the force (means no pulling), not needing confining air to protect the roller bearings against dust, as well as a reduction in extensive maintenance work, etc, have been converted into a highly efficient grinding system. The high content of preassembled components, a reduction in mechanical parts and sensor technology inside the mill, exceptional damping characteristics, and operational continuity are the resulting sum of the quadropol concept.[1]

The idea behind the quadropol is convincing and, of course, part of a gradual development process to meet varying demands. The right mill configuration can provide the desired throughput and fineness, smooth operation, as well as help minimise unscheduled downtime. Plant availability is essential. Generally, the causes of malfunctions are diverse and cannot always be predicted. Tramp metal, an unstable grinding bed, interruption of material feed, faults in the gas connection and maloperation are examples of factors that can also lead to a shutdown.



Cementos Progreso's 4500tpd plant in Guatemala has installed a polysius quadropol for raw material grinding (QMR²) and two identical quadropol VRMs for cement grinding (QMC²)

No time for stoppages

Maintenance work is a cost driver and therefore, needs to be taken into account when choosing a grinding system. Planned maintenance work, which includes inspection, servicing, repairs and improvement, is clearly defined. Maintenance work is dependent on, but not limited to, regular visual inspections during operation, wear rates and wear measurement, analysis of plant/machine operating values and the replacement of parts according to product guidelines (see Figure 1).

Mill availability is the ratio between uptime and total available operation time (downtime plus uptime). Uptime is operating time minus planned maintenance work and stoppages. The objective is to reduce downtime to a minimum, even during planned stoppages.

The quadropol's reduction in mechanical components lessens the probability of failure and maintenance work, which is the philosophy behind the quadropol concept. A further key role in cutting downtime is

played by the mill foundation, which has been optimised to reduce vibrations.[2]

Built to last

The mill foundation, ie, the basic block with its four concrete pylons, is responsible for the smooth running of the mill. The roller units and mill housing are not connected, leaving the mill housing free of forces. The mill foundation is designed according to the force transmission, which results in a vibration value due to the grinding process of less than 2mm/s, measured at the roller units. Of course, to absorb the grinding forces and load spectrum, and to ensure the damping behaviour, reinforcement and post-tensioning are needed. Influencing factors, such as yield strength and tensile strength, must be accurately taken into account. The total volume of the foundation corresponds to the values that are available on the market. The requirements of the execution are standard and part of the civil engineering process. Local standards are also considered as well as the local procurement of building materials such as rebars and tensioning devices, including civil engineering. Therefore, a big base frame for the concrete basic block is not necessary – only two small base frames for motor and gearbox are required.

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In addition, the reinforced concrete leads to much lower total construction costs.

The design with steel pylons was not followed up in the past because during rough running, cracks in the welded design could not be ruled out. This would lead to unscheduled downtime for a longer period of time.

Table 1: QMR² performance values of quadropol cement mills during operation, Cementos Progreso, Guatemala

Design parameter	Nominal	Operation QMR² No 1 (average)	Operation QMR² No 2 (average)
Throughput (tph)	≥180	195	188
Residue (cm^2/g acc to Blaine)	≥4100	4057	4117
Electrical power consumption – grinding system (kWh/t)	≤26.00	23.80	23.95

Feed: 64.3% clinker, 24.1% pozzolana, 4.5% gypsum, 2-4% limestone, 3.1-5.1% filter dust

Figure 1: simulation tool for maintenance sequences

Accelerated on-site installation

With its large number of preassembled components, quadropol mill equipment is designed for smooth on-site installation. The weight of the four preassembled roller units of a medium-sized mill (approximately 450tph) is around 50 per cent of the total weight of the mill and separator.

The preassembled roller unit is installed at the end of the erection process. All of this results in, but is not limited to, less:

- on-site assembling
- alignment of the mechanical components
- welding
- skilled workers
- mobile crane usage
- supervision.

Compared to alternative solutions, time savings of up to 50 days are possible.

In addition, less erection effort and fewer steel structures for civil works provide key benefits in terms of total costs.

Design and performance

VRMs are an essential part of the cement manufacturing production process to grind raw materials (the quadropol QMR²), coal (QMK²) and, increasingly, binding agents or slag (QMC²/QMS²). To ensure the required product fineness for all applications, a technically reliable solution within the production process also includes thyssenkrupp's latest-generation high-efficiency sepol® separator.

For raw grinding the HDZX double cyclones are part of the technical solution and include latest process know-how. The hydraulic system is smart and compact: one hydraulic unit serves the four roller units. The grinding force for comminution is generated solely by one hydraulic cylinder per roller unit. This concept also requires only one piston accumulator to act as the spring system.

Due to the "pushing principle" to generate the grinding force for the comminution process, the hydraulic and mechanical components are positioned in a compact configuration on the same mill level, combined in the roller unit. No swing-out cylinder is needed for maintenance purposes. Accessibility is very good and it is possible to easily carry out maintenance work without having to remove the roller unit.

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In addition to the advantages of good mill design, the spotlight on operating costs has become even more important. The energy consumption of a mill, as well as the entire grinding system, plays a significant role in decisions by plant operators. Even if not shown in detail for selected references, producers that have installed the quadropol have been convinced by predicted low specific power consumption values. As a rule, a lower specific power consumption of the mill system can be converted, in certain circumstances, to higher mill throughput during operation. This is dependent on material properties, hot gas supply and the right mill set-up.

Operational consistency

Cementos Progreso, Guatemala

Cementos Progreso, a leading cement manufacturer in Guatemala, ordered a turnkey cement plant from thyssenkrupp with a 4500tpd kiln line. Now in operation, the line is equipped with a quadropol VRM for raw material grinding and two identical QMC^2 VRMs for cement grinding. Performance tests were executed over three days, and showed a smooth and reliable performance of both cement grinding systems.

Cementos Progreso commented: "We are very satisfied with high reliability of the two cement mills, which ensures the quality and quantity of our products."

In terms of throughput and residue, the cement mills are running with similar values (see Table 1). The final configuration resulted in a significantly low specific power consumption and thus a stable operating point.

Figure 2: QMR^2 for raw material grinding

Table 2: QMR^2 performance values during operation, Yamama Cement

Design parameter	Nominal	Test result QMC^2 No 1 (average)	Test result QMC^2 No 2 (average)
Throughput (tph)	≥425	467	471
Residue (% 90µm)	≤12	10.70	10.70
Test time: 3 x 24h each			

Yamama Cement, Saudi Arabia

Yamama Cement's two new 10,000tpd kiln lines in Saudi Arabia are also equipped with state-of-the-art polysius technology (see Figure 2). Line 1 is in operation and all performance guarantee tests have been completed. Decades of experience in technological solutions proved essential as thyssenkrupp also commissioned Yamama's first 10,000tpd line in 2007.[3]

The quadropol performance tests for Line 1 of the new project have been performed in recent weeks, partly each on consecutive days. The final set-up of the mills has resulted in good operational performances.

Again, in terms of throughput and residue, both mills are running with almost identical values (see Table 2). It was also possible to achieve a low level of vibrations, ensuring a smooth and stable operation point. The material feed moisture was 2.61 per cent, meaning it was fairly dry. At the end, the injected water quantity required on the table during operation was only 0.78 per cent.

An all-encompassing solution

When developing and designing grinding systems for the cement industry, it is essential to create a technically viable solution that meets market requirements. Besides a general feasibility study and further development, this calls for a holistic approach that encompasses a stable process and optimised machine design, including civil engineering, clear assembly sequences and simple modes of operation, as well as taking economic considerations into account. Ultimately, reliable operations ensure minimum downtime for a grinding plant. ■

"We are very satisfied with the two cement mills of high reliability which ensure the quality and quantity of our products."

Cementos Progreso, Guatemala

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