

Industrial Solutions

Autogenous, semi-autogenous and ball mills for wet and dry grinding.

High performance system configurations for every application.



thyssenkrupp





High-performance system configurations ...

As one of the world's leading companies in the plant engineering field, ThyssenKrupp Industrial Solutions has the many years of knowhow that is needed in order to supply the minerals industry with innovative and high-quality, autogenous/semiautogenous and ball mills for wet and dry grinding.

Wet grinding

- ✓ Autogenous and semiautogenous mills
- ✓ Ball mills
- ✓ Rod mills
- ✓ Scrubbers
- ✓ Lime slaking machines

Dry grinding

- ✓ AEROFALL mills
- ✓ Ball mills
- ✓ Rod mills
- ✓ Separators
- ✓ Dryers
- ✓ POLYCOM® high-pressure grinding rolls
- ✓ Roller mills



... for every application

Our continuous development and optimisation of machine and plant concepts, processes and equipment guarantees customers state-of-the-art, reliable technology with high energy and resource efficiency and minimum operating expenses.

As a solution provider, we develop innovative processes and systems for our customers. A network of dedicated employees in our offices all around the world design these cutting-edge turnkey solutions.

Our development activities and resultant innovations are oriented towards assuring sustainable environmental practices. We concentrate on current key technologies in order to maintain our leading position with regard to highly advanced products. Our grinding systems fulfil the most stringent quality requirements and provide long

service lives and low maintenance requirement.

We offer comprehensive solutions ranging from project elaboration, engineering and design, delivery, field assembly up to plant commissioning, including customer personnel training and service contracts.

Our strong performance applies across the board: to complete production lines, individual products and plant modifications.

Global knowhow as well as a comprehensive range of test equipment in our Research & Development Centre and powerful simulation tools, which enable us to design complex grinding circuits, have laid the foundation for developing high-quality and cost-effective solutions for individual applications.



Grinding tests support the sizing of the equipment.



Mill shells and sliding shoe bearing assemblies

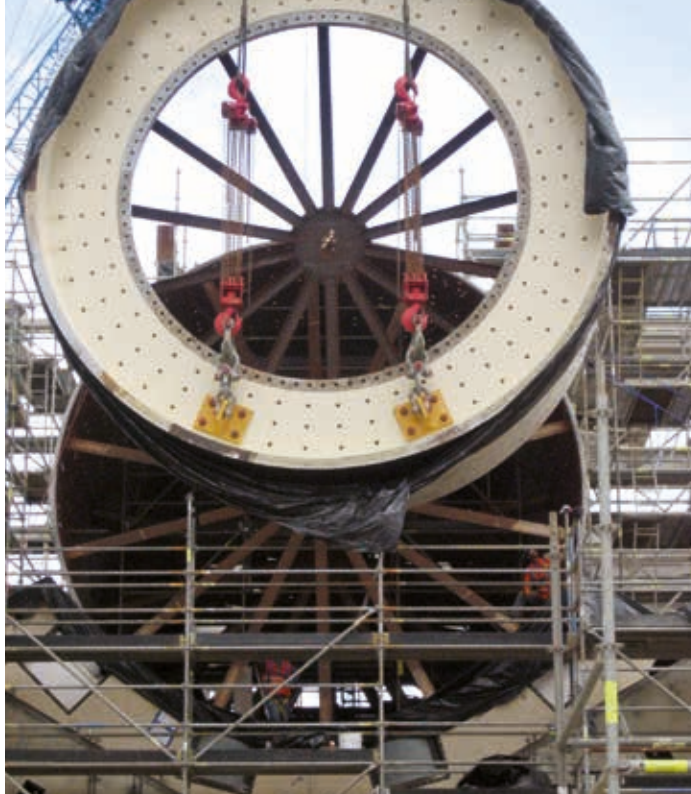
Ball mills, autogenous mills and semiautogenous mills from ThyssenKrupp Industrial Solutions with diameters above 8 m and 11 m respectively and drive powers exceeding 22 MW are in highly successful operation all around the world, grinding copper ore, gold ore, iron ore and other mineral materials.

The mill shells are delivered as a single unit or split into several parts. Large-diameter mill shells are transported to the plant site in sections. The sections are then welded together or flange-connected. The POLWELD® field welding process from ThyssenKrupp Industrial Solutions is a unique welding concept for assembly of tube mills on the plant site. The customer profits from troublefree performance of the work and high welding quality.

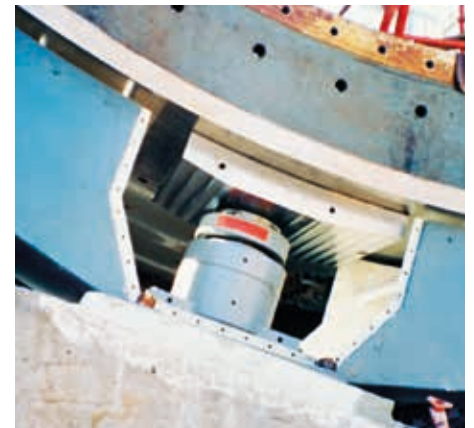
For the grinding of ores that form highly acid pulp, ThyssenKrupp Industrial Solutions equips the mills with special corrosion prevention systems.

With the unique POLWELD® site welding concept for precise alignment and welding of the mill sections on site, ThyssenKrupp Industrial Solutions offers a favourably-priced technical alternative to flanged mill shells.





Installation of a sliding shoe bearing assembly.



Large mill shells are transported in sections and welded at the plant site.

Mill shell

Since 1976, ThyssenKrupp Industrial Solutions has only built mills with circumferential and sliding shoe bearing assemblies. More than 400 such mills are meanwhile in successful operation all around the world, serving different industrial sectors.

Mills with circumferential and sliding shoe bearing assemblies provide the following advantages:

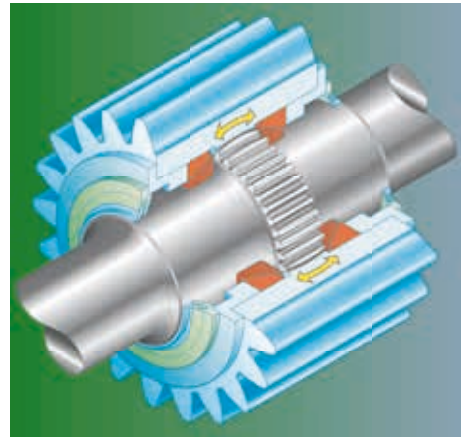
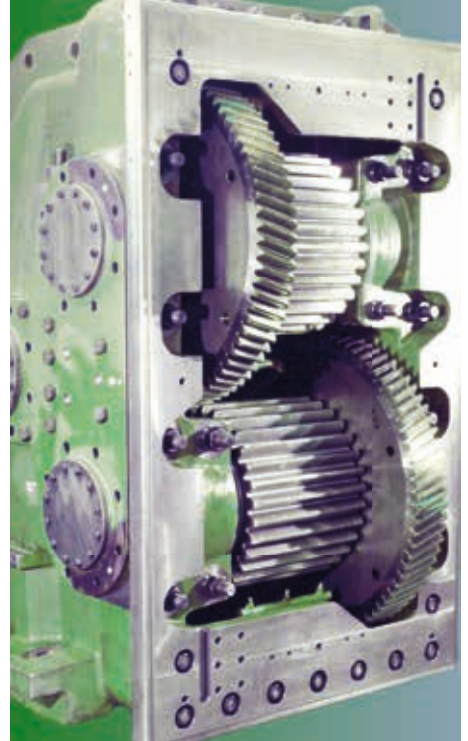
- ✓ they can use all mill drive systems on the market
- ✓ there is no need for castings with their associated manufacturing and delivery time risks
- ✓ the mill inlet and outlet can be designed to suit the process technological requirements
- ✓ due to the shorter inlet cylinder, critical feed materials do not cause blockages
- ✓ good accessibility of the mill interior
- ✓ flanges are fewer and lighter, facilitating transport and assembly
- ✓ the foundations are smaller, reducing the mill's footprint and cutting the cost of buildings
- ✓ ideal for ring motor drives

Sliding shoe bearing assembly

Depending on the mill size, the mill shell runs on two, four or six sliding shoes per bearing assembly. Any radial eccentricity of the mill shell resulting from bending, thermal deformations and manufacturing tolerances are compensated by the pivot-mounted support of the bearing shoes. Depending on the expected load, the mill is equipped with either hydrodynamic or hydrostatic sliding shoe bearing assemblies.

Hydraulic cylinders installed in the base of the bearing allow lifting and positioning of the entire mill in order to compensate for foundation settlement or to install or remove bearing shoes without complicated supporting of the mill shell. Load cells in the base of the bearing allow the mill weight to be recorded.

Proven seals prevent dirt or splash water from entering the bearing housing. As the mill shell is a welded assembly, there are no complicated and heavy end wall castings. Straight mill end walls offer the advantage that the mill liner plates have a simple shape and are quick and easy to replace.



Drive systems

ThyssenKrupp Industrial Solutions selects the appropriate drive variant for the specific application requirements. COMBIFLEX®, ring motor and direct drives are among the well-trying and reliable high-performance systems. If requested, other types of drive and motor can also be installed.

COMBIFLEX® drive

The COMBIFLEX® drive combines the advantages of the ring motor drive, such as the lowest maintenance requirement and high availability, with the advantages of a normal girth gear drive, such as favourable capital cost. The gear unit with its integral self-aligning drive pinions forms a single unit together with the girth gear, sliding shoe bearing assembly, slide ring and axial guide. Every COMBIFLEX® drive is equipped with its own auxiliary drive unit.

COMBIFLEX® drives can be designed as single drive or dual drive. If extremely high drive powers are required, four COMBIFLEX® units can be installed for transmitting drive powers of up to and exceeding 30,000 kW.

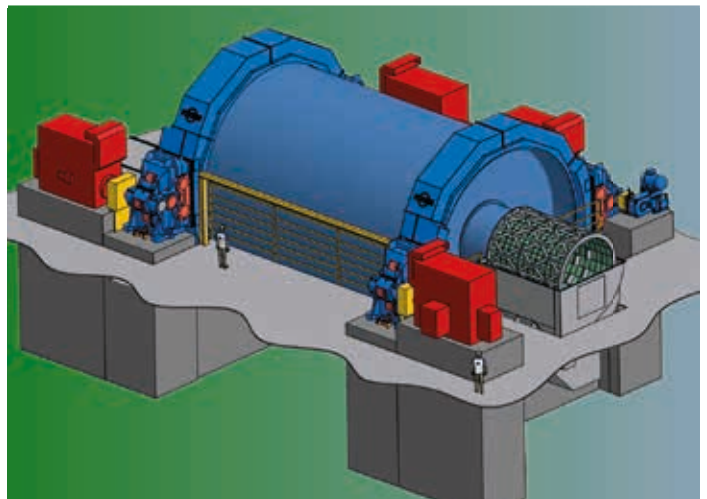
High operational reliability:

Thanks to its self-centring hardened and ground pinions and the uncomplicated oil lubrication system, the drive unit provides optimum operating conditions.

Drive pinion of the COMBIFLEX® drive: the self-aligning drive pinions compensate wobbling of the girth gear.

Minimum maintenance requirement and low operating expenses:

The drive requires no readjustment. Instead of the grease lubrication of conventional drives, a simple central oil supply system serves the girth gear, pinion, sliding shoe bearing and gear unit, also saving on the waste grease disposal costs.



Wet mill with four COMBIFLEX® drive units.

Brake of a
ring motor drive.



Ball mill with ring motor drive.

Ring motor drive

The ring motor features noncontact transmission of the driving torque to the mill shell by means of magnetic forces. As this produces no component wear, this type of drive provides high availability and long service life.

Another significant aspect is the controllable speed. Due to the higher capital costs for ring motor drives, they are generally only used if very high drive powers are required.

Shell supported ball mills are ideal for the use of ring motor drives:

- ✓ Because of the high rigidity of the mill shell, troublefree transmission of the magnetic forces is assured.
- ✓ Due to the individual self-adjustment of the sliding shoes, the pole pads attached to the mill shell can be centered in the stator of the ring motor.

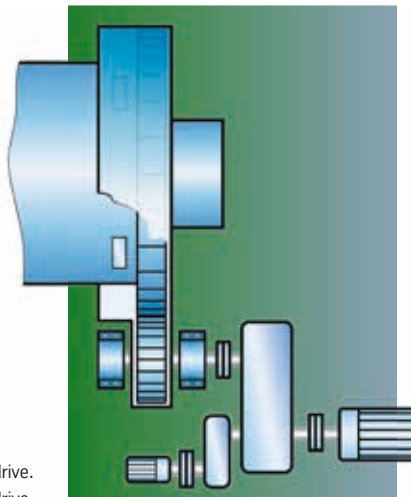


SAG mill with COMBIFLEX®
drive for gold ore grinding.

Direct drive

Another drive system, intended especially for smaller mills, is the direct drive.

Similar to the COMBIFLEX® drive system, the direct drive also integrates the girth gear, drive pinion, and sliding shoe bearing with slide ring into a single housing. The three-stage gear unit with integral auxiliary drive is installed separately.



l. to r. Principle of the direct drive.
Tube mill with direct drive.





SAG and ball mill for the wet grinding of gold/copper ore in Australia.

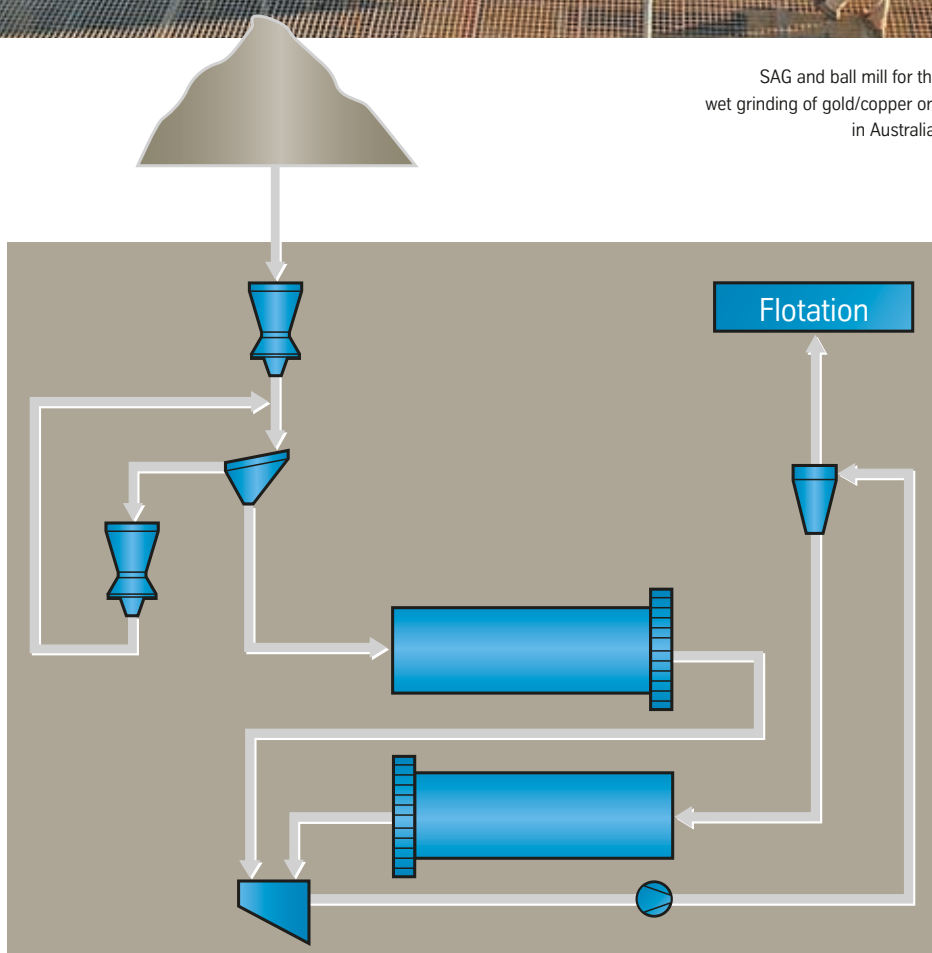


Wet grinding

Grinding is one of the most energy-intensive production stages and therefore has a substantial energy-saving potential.

The main demands made on grinding plants are low operating costs and high availability, even when grinding extremely abrasive materials.

These demands are met by all grinding plants made by ThyssenKrupp Industrial Solutions: All around the world, our autogenous mills, semiautogenous mills and ball mills are known for extremely high availability rates.



Plant configuration of the first generation.



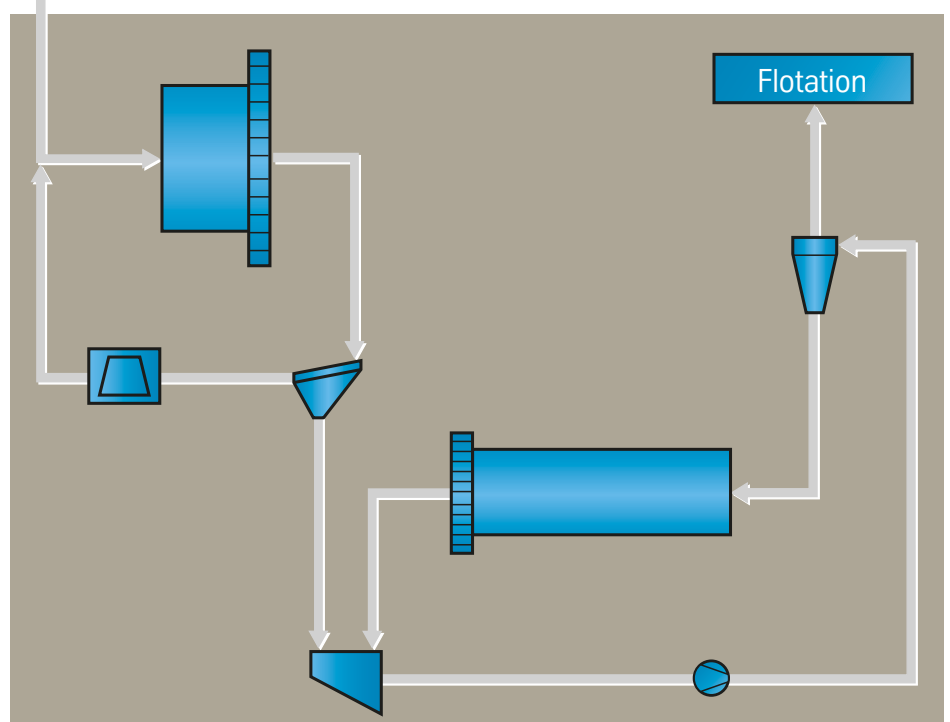
SAG and ball mill for the wet grinding of gold ore in the Dominican Republic.

The core issues of plant technology development have always been reducing the power requirement and raising the throughput.

The first-generation plants consisted of grinding circuits with a three-stage crushing system, primary mills and secondary mills.

In the second generation, SAG mills replaced the second and third stages of the crushing system and also the primary mills.

Example configuration for the second generation.





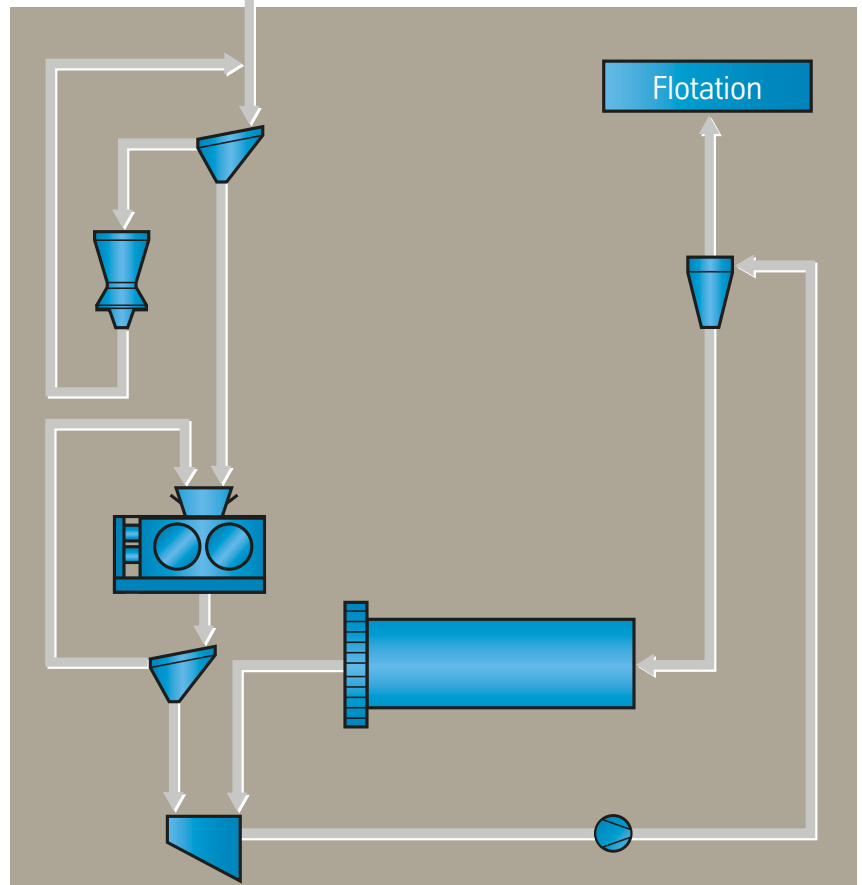
Copper ore processing in South America:
the primary ore grinding stage consists of four POLYCOM®
high-pressure grinding rolls, while four wet process ball
mills perform the final grinding.

All around the world, mines are having to work ore
deposits with declining mineral contents. As a con-
sequence, grinding plants in the minerals industry
are being designed for ever increasing throughput
capacities.

Grinding systems of the third generation also assure
cost-effective processing and sparing use of re-
sources.

In this respect, the combination of POLYCOM® high-
pressure grinding roll and ball mill represents tech-
nological competence for tomorrow's world. These
systems are the only option for processing materials
with strongly varying grindability.

Example configuration
for a third-generation
grinding circuit.



Dry grinding

In the minerals industry, dry grinding plants are primarily used when the downstream preparation process requires dry material, or in order to save valuable water resources.

Plants from ThyssenKrupp Industrial Solutions are in successful operation all around the world, grinding and drying gold ore, iron ore, iron ore concentrate, limestone, cement clinker, lime and coal as well as other mineral raw materials.

The single-compartment mill is ideal for the grinding of fine-grained feed material. One typical application is the combined grinding and drying of iron ore concentrate with a high feed moisture content (up to approx. 8 %).

Single-compartment mill

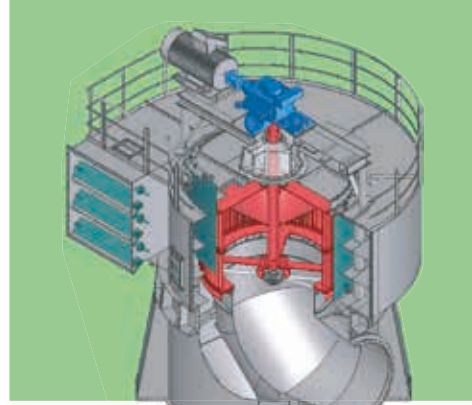
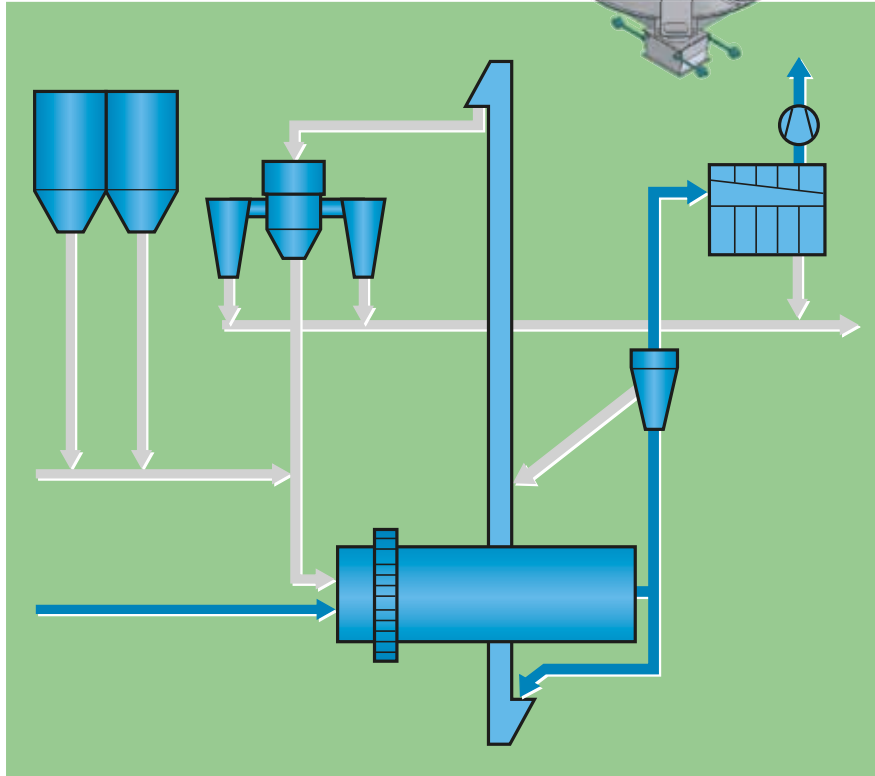
The crushed feed material components are dosed to the single-compartment mill, where they are dried and ground. The ground material is mechanically discharged via a discharge diaphragm at the end of the single-compartment mill and then fed to a dynamic separator for classification into fine product and oversize. The oversized material is returned to the mill for regrinding.

For drying the mill feed material, the single-compartment mill is equipped with a drying chamber.

Single-compartment air separator mill with drying chamber for iron ore grinding.

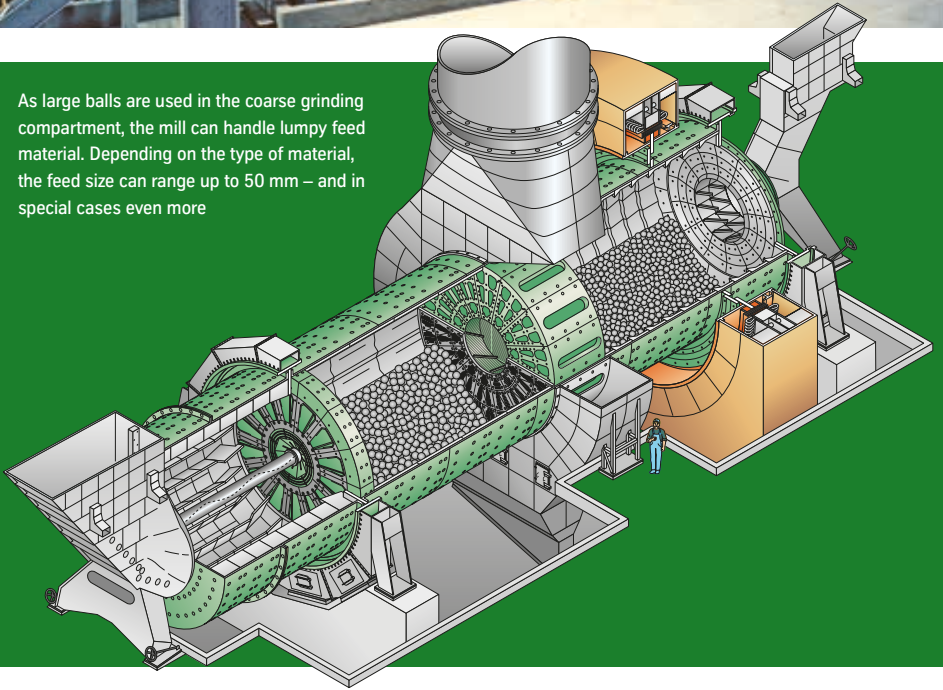


High-efficiency separators minimise the power consumption of dry grinding systems. ThyssenKrupp Industrial Solutions separators enable adjustment of the product quality during operation to suit current requirements.





As large balls are used in the coarse grinding compartment, the mill can handle lumpy feed material. Depending on the type of material, the feed size can range up to 50 mm – and in special cases even more



Picture top left:
DOUBLE ROTATOR® for gold ore grinding in the USA.

DOUBLE ROTATOR®

The DOUBLE ROTATOR® grinding process involves drying, pregrinding, separating, fine grinding and renewed separating, all in one system. The material components are dried in a drying chamber, then primary ground in the coarse grinding compartment. After leaving the mill via the central discharge, the material is conveyed to the high-efficiency separator for classification into fine product and oversize.

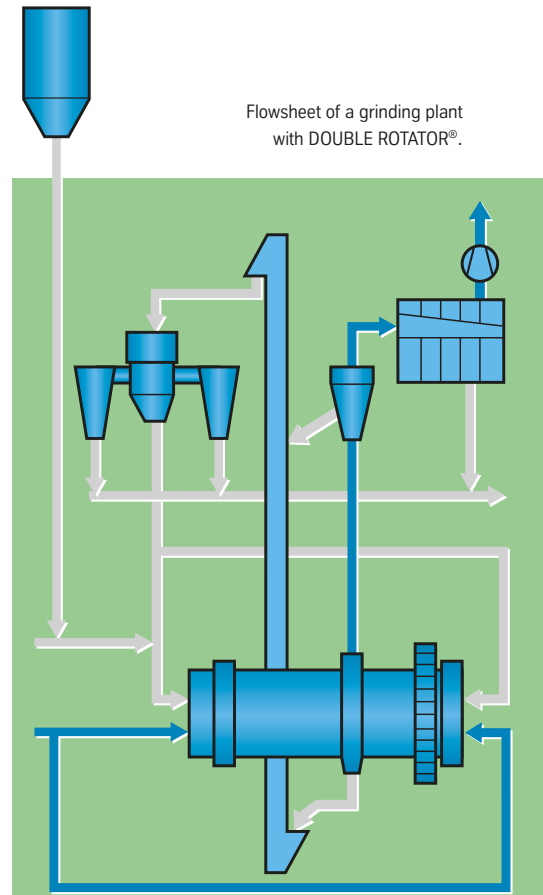
Most of the oversize material is fed to the fine grinding compartment, while a small proportion is returned to the coarse grinding compartment to improve the flow properties of the mill feed material. The material ground in the fine grinding compartment also leaves the mill via the central discharge and is then classified.

The hot gases required for drying the material, as well as the gas quantity needed for ventilating the mill, are extracted via the central discharge and routed to a separator.

The separator splits the entrained material into coarse and fine material, and then the coarse material is supplied to the high-efficiency separator for post separation. The finished material contained in the gas stream is collected in a cyclone / filter combination or directly in the filter. Even if a large flow volume of gas is needed for drying very moist materials, this has no negative effect on the grinding process, as it is only drawn through the coarse grinding compartment.

The DOUBLE ROTATOR® is not sensitive to feed size fluctuations and is suitable for grinding even the hardest and most abrasive materials.

The mill's division into two grinding compartments and the intermediate material separation permit optimum adaptation to the coarse and fine grinding requirements of the respective feed material. Compared with other tube mill systems, the DOUBLE ROTATOR® therefore has the lowest specific power requirement.





Central discharge of a DOUBLE ROTATOR® for gold ore grinding by the dry process.

AEROFALL mill

ThyssenKrupp Industrial Solutions offers AEROFALL mills as autogenous or semi-autogenous mills for drying and grinding.

A large diameter: length ratio is characteristic for these mills. Units with up to 10.5 m diameter, 4,500 kW drive power and 1,200 tph throughput have been installed.

The feed material can have a lump size of up to 500 mm.

One fundamental advantage of this mill is that it even accepts sticky materials that have moisture contents of up to 20 %. If this mill is used, secondary and tertiary crushers are not required.

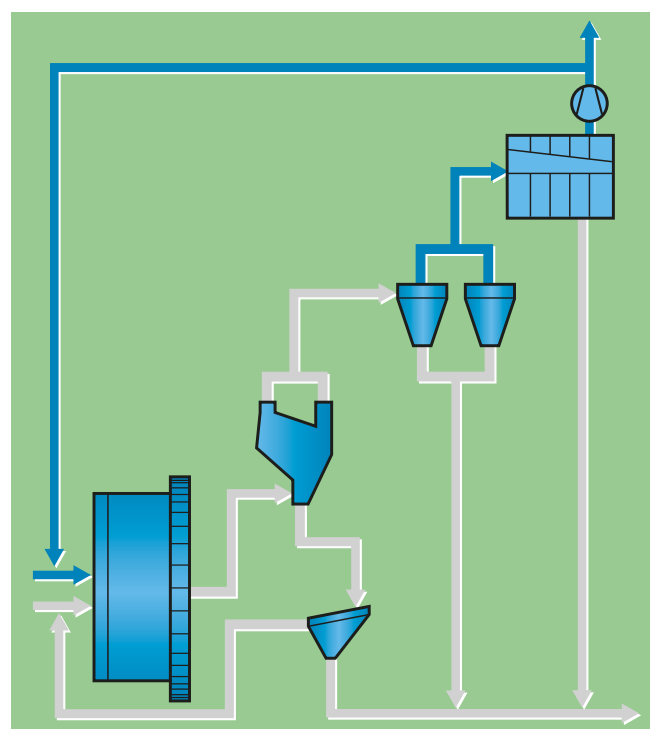
The mill lining is fitted with lifter bars and guide rings, the so-called deflectors. As the mill rotates, the material is lifted by the bars to the point where it cataracts to the bottom of the mill.

The comminution process is thus performed autogenously by material impacting on material. The deflectors guide the falling material to the middle of the mill, improving the autogenous comminution effect.

The separator and the cyclones installed in the grinding circuit separate the fine and coarse material. In semiautogenous mills, the comminution process is assisted by adding a small charge of grinding media.



AEROFALL mill for iron ore grinding.



Flowsheet of a grinding plant with AEROFALL mill.



Securing and shaping the future

Dialogue with customers is essential for the work of our scientists, development engineers and service team. The customers' requirements determine our thinking and acting.

Research and Development. ThyssenKrupp Industrial Solutions has the knowhow and the equipment (the research centre with its ultramodern machines is one of the world's leading development establishments for basic material technology) to provide a suitable plant concept for the individual properties of the respective ore.

From laboratory-scale to industrial reality:

On the basis of the material analysis, our comprehensive material database enables quick and reliable classification and evaluation of the ore's grindability, hardness, abrasiveness and agglomeration behaviour, thus assuring optimum system design.

High-performance simulation programs support the selection of machines and systems and forecast the wear rates, energy requirements, mill circuit material balances, etc., thus assuring future-oriented, custom-tailored plant solutions with the lowest possible operating expense.

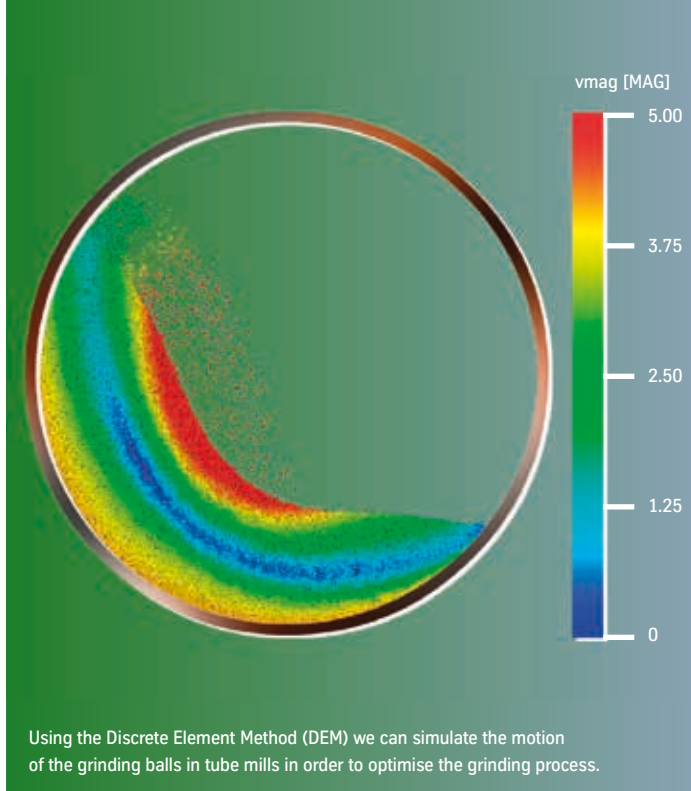
This applies in equal measure to new plants, the upgrading of existing facilities and the opening up of new fields of application for proven technologies and services.

Service. In this era of highly complex plant configurations, service is the basis for achieving optimum plant operation and thereby maintaining and strengthening the trust and loyalty of our customers.

Thanks to our global network, ThyssenKrupp Industrial Solutions is present all around the world, providing customers with a helping hand – quickly and reliably.

In addition to the everyday challenges of plant operation, the production process has to be constantly checked with regard to economy of operation and competitiveness. If necessary, the equipment has to be put in future-oriented condition by incorporating the latest technological developments or spare parts. On the basis of comprehensive knowhow, our specialists diagnose weak points in the plant operation, offer solutions and assist in the elimination of problems.

Furthermore, ThyssenKrupp Industrial Solutions offers a broad range of services and preventive checkups aimed at minimising the risk of lengthy plant stoppages:



High-performance calculation and simulation programs support our machine sizing and designing work.

From top to bottom

During the POLDRIVE® service, the girth gears and pinions are examined and appropriate preventative measures are proposed.

Thanks to our POLWELD® service, it is no problem to assemble even large mill shells directly at the construction site.

POLWELD®. The global market is demanding tube mills with ever increasing grinding capacities. Due to the higher throughput requirements, the dimensions of new machines have increased so much that the mill shells have to be transported to the plant site in several sections. Using our site welding concept, POLWELD®, experts from ThyssenKrupp Industrial Solutions precisely align the individual sections on site and then weld them together. This unique welding concept provides plant owners with a favourably-priced technical alternative to flanged mill shells.

POLDRIVE®. Our POLDRIVE® service is primarily aimed at ensuring good condition of pinions and girth gears. POLDRIVE® is a special precautionary check for large tooth gearing, during which the drive units are precisely analysed and – if necessary – appropriate measures are proposed for achieving optimum drive unit service life.

Ball mill filling level measurement for dry process mills

For simple filling level measurement by MLC3 a microphone is installed directly adjacent to the mill to receive the produced sound waves. The recorded signals are analysed and transmitted to the process control system. The alternative process is wireless filling level measurement, in which the measuring microphone is mounted on the mill shell. The signals are thus interference-free and

therefore provide an even more precise representation of the mill filling level. The measurement results are transmitted to the process control system by wireless link.

POLRED®. ThyssenKrupp Industrial Solutions introduced POLRED® as a comprehensive service concept for COMBIFLEX® and planetary gear units. POLRED® reduces stoppage times and gear unit damage. The concept comprises several modules (maintenance, online condition monitoring system, lubricants, wear parts and spares).

Industrial Solutions
Resource Technologies

thyssenkrupp Industrial Solutions AG
Graf-Galen-Strasse 17
59269 Beckum, Germany
Tel.: +49 2525 99-0
E-mail: info.tkfen@thyssenkrupp.com
www.thyssenkrupp-industrial-solutions.com

© 2016 Product specifications and prices are subject to change without notice or obligation. The photographs and/or drawings in this document are for illustration purposes only. The operation values are considered to be approximate and will be finally determined on the basis of the specific task and the material characteristics. The only warranty applicable to our equipment is the standard written warranty applicable to the particular product and sale and thyssenkrupp makes no other warranty of accuracy, reliability, completeness, merchantability or fitness for any purpose, express or implied. Products and services listed may be trademarks, service marks or trade-names of thyssenkrupp and/or its subsidiaries in Germany and other countries. All rights are reserved.

engineering.tomorrow.together.