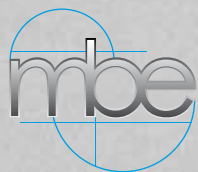
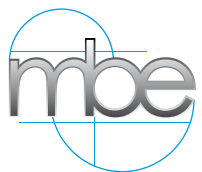




PALLA® VIBRATING MILL



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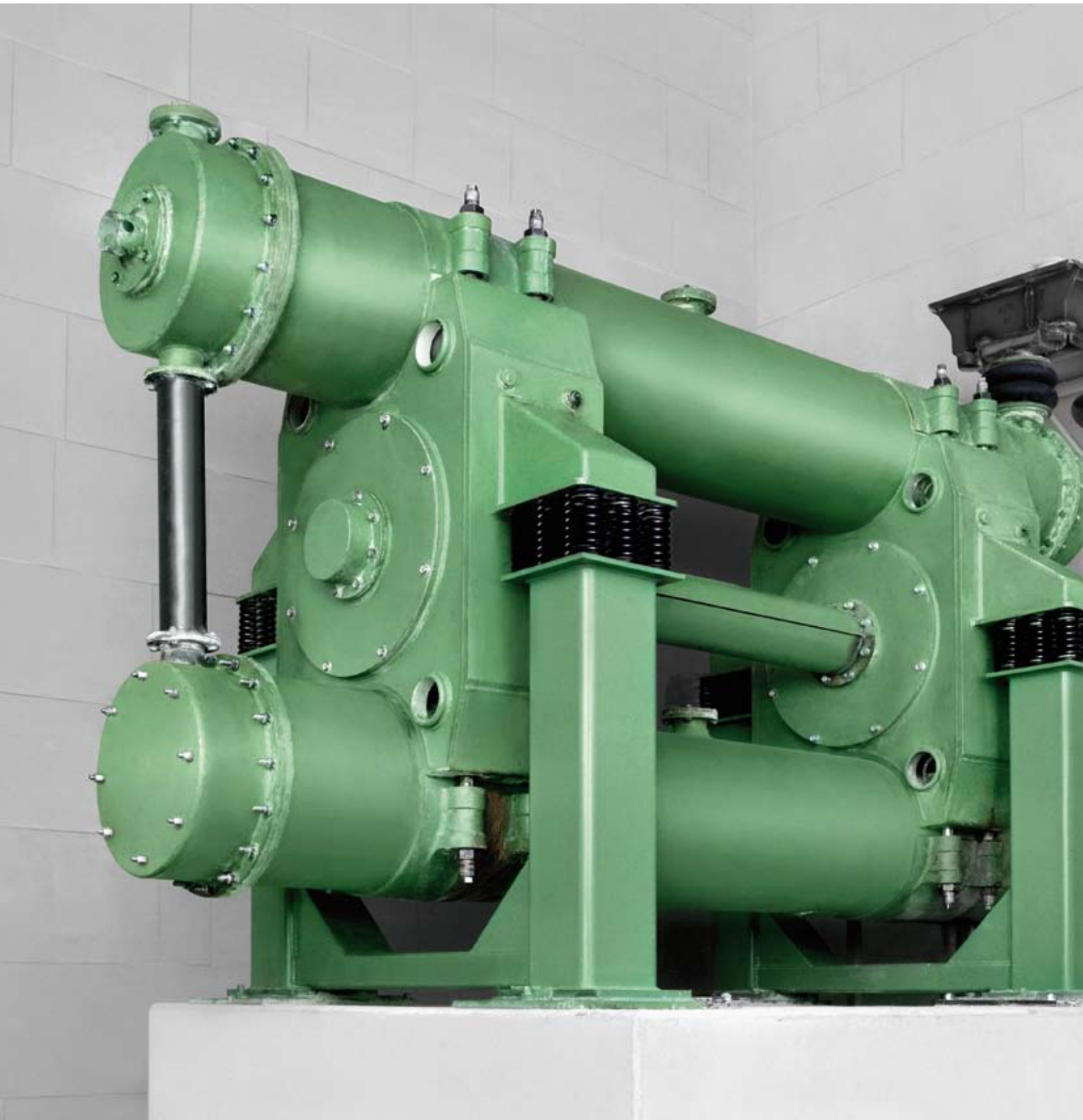
The PALLA Vibrating Mill is used in a wide range of applications for process engineering duties. Due to its easy operation, versatility and operation efficiency the PALLA Vibrating Mill gains in importance in the mineral processing industry.

This PALLA brochure focusses on the technology and the principle of ultra-fine grinding. In addition, it describes a variety of operations and the benefits of these different operating modes regarding product size and efficiency.

You will also learn more about the construction and design of the PALLA particularly on special features and development.

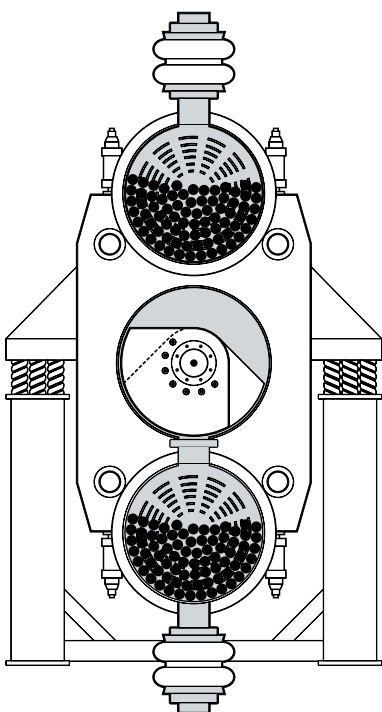
THE ESSENTIALS ENDURE. With its more than 150-year history, while permanently being revised and improved, the vibrating mill technology perfectly matches the essentials of our company's principles, which is, first of all, continuity with the courage to face change.

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The idea of employing a swinging motion as a grinding principle was developed in the past century. Since then the demands to product grain size in the mineral processing industry have been constantly increasing, therefore the vibrating mill has been subject to a continuous improvement.

The general purpose of size reduction is to produce a well-defined grain size in order to achieve an enlargement of the particle surface or to decompose adhered materials. Furthermore ultra-fine grinding is applied for surface activation within the mechanochemistry. When increasing the particle surface, a modification of the original mechanical and chemical character may occur as a result of mechanochemical reactions or activations.

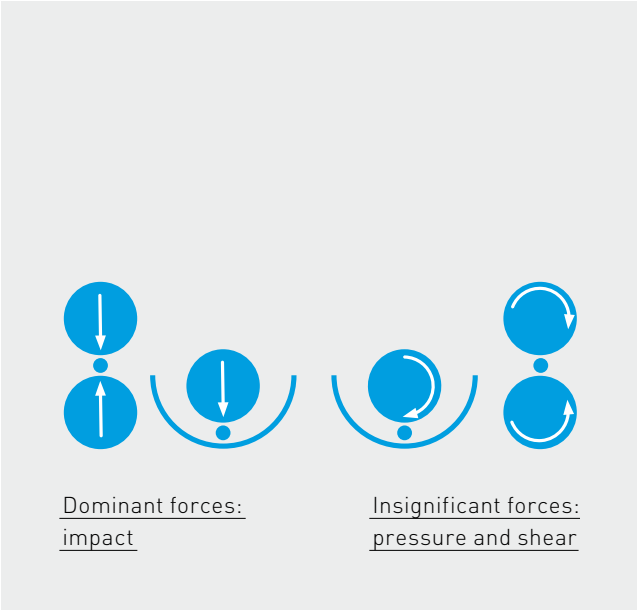


Vibrating mills have hitherto proved their worth as individual machines. Vibration grinding represents an economic and reliable solution since the required product grain sizes can be achieved in a simple continuous grinding process without air classifying.

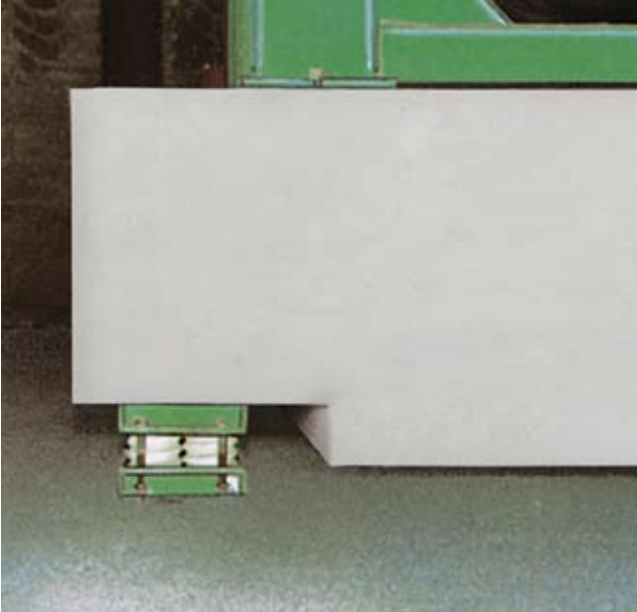
For over 160 different materials, from soft to very hard, the vibrating mill has been successfully established for grinding, homogenizing and activating. A high filling degree of the grinding cylinders and a low air throughput appear to be beneficial for materials like metals, coal, coke and other organic materials, which tend to increase the risk of dust explosion.

CONCEPTION. The wide range of application can be described by the following mill characteristics and operating conditions:

- dry or wet grinding
- different options for grinding cylinder connection
- continuous or discontinuous grinding
- indirect cooling or heating
- dusttight, use of inert and protective gas, grinding compartment with overpressure and negative pressure, special designs
- grinding at cryogenic temperatures (PALLA VM-KT or PALLA UT)
- different grinding media (rods, balls, cylpebs)
- different materials for grinding media (wear-resistant special steel or ceramic material)
- filling degree of grinding cylinders
- rotating frequency
- acceleration

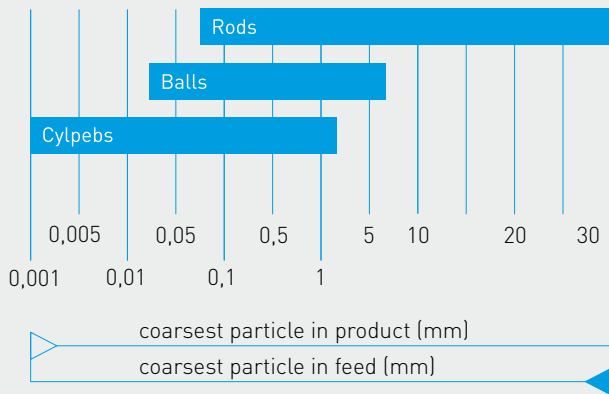


Swinging body
supported on steel springs



PALLA mounted on
anti-vibrating foundation

Operative range of grinding media



PALLA® GRINDING PRINCIPLE

Usually rotation impulses of 1.000 min^{-1} are transferred by the effect of unbalanced weights from the surface of the grinding cylinders to the grinding media which performs an almost ideal circular movement. Depending on the frequency and the unbalanced mass, an acceleration of several g can be generated ($g = \text{acceleration of gravity}$). The grinding effect is caused by milling the feed material in between the elements of the grinding media and between the elements of the grinding media and the cylinder walls. Size reduction in vibrating mills is primarily caused by the impact energy of the grinding media rather than by friction or by acceleration of the feed material. The grinding cylinders are filled up to 65% with grinding media.

The diagram represents the general trends in media selection. Furthermore the specific material properties like hardness, density, grain shape, surface properties etc. have to be taken into account.

Three types of grinding media can be used in vibrating mills which, due to their geometry, cause the different impulse transitions:

- **Rods:** linear impact energy
- **Balls:** punctual impact energy
- **Cylpebs:** linear and laminar impact and friction energy

Consequently for achieving an optimal energy transmission the correct choice of grinding media is essential. The feed is constantly charged to the grinding cylinders and flows into the gaps of the grinding media via vibration where size reduction and transportation occurs simultaneously. The spiral transportation of material through the horizontal grinding cylinders is based on displacement of material and is supported by the vibrating motion. The repose angle at the outlet which controls the throughput depends on type and size of grinding media, feed size, material properties and circular motion. The degree of size reduction mainly depends on retention time and besides others on the throughput.



Grinding cylinder with rods

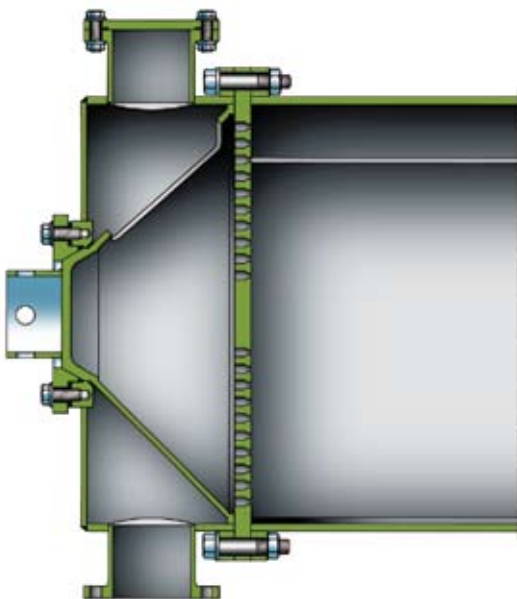
The processing of materials of different structure and chemical composition requires a wide and versatile milling conception which can be realised with vibrating mills in the following basic sizes PALLA VM, PALLA 20U, PALLA 35U, PALLA 50U, PALLA 65U. The throughput depends not only on the machine size but also on various other parameters like frequency, amplitude of vibration, arrangement of grinding cylinders and grinding media. With installed drive capacities of up to 200 kW for wet grinding processes, the PALLA is one of the most powerful and versatile vibrating mills available on the market.

TYPE	DIAMETER (mm)	LENGTH (mm)	THROUGHPUT (kg/h)	POWER	
				dry (kW)	wet (kW)
VM	200	300/600	0,1 – 150	1,9	-
20U	200	1.249	20 – 500	5,5	-
35U	350	2.306	50 – 3.000	22	-
50U	500	3.400	200 – 10.000	75	90
65U	650	4.525	400 – 20.000	160	200

GRINDING SYSTEMS. The grinding cylinders are manufactured of high-grade steel. The tube lengths of all models ensure a superfine grinding even without a separator. Inlet and outlet caps have been flanged to the tube ends for admitting and discharging the material. A grit plate fitted between the cylinder and the outlet cap retains grinding media (e.g. cylpebs or balls) but allows the material to pass through. Adjustable retaining cones in the outlet caps permit optimum utilisation of the grinding compartment.

Sockets mounted to the cylinder top permit quick inspections of the grinding compartment and refilling with cylpebs and balls.

Flexible and airtight components couple the mill to upstream- and downstream-mounted proportioning and conveying equipment so as to minimize dust emissions. For this reason, connection to a dust collector is normally not necessary. All flange connections are sealed by temperature-resistant O-rings. The cylinders are protected by highly wear-resistant and easily replaceable liners. For iron-free grinding these liners are made of ceramic. Since the liners are subject to low wear, they achieve long service spans.



Grinding cylinder with grit plate and retaining cone

Liner with fastening device



FASTENING OF GRINDING CYLINDERS. The cylinders of the PALLA Vibrating Mill are fastened to the webs by the way of clamps and anti-fatigue screws. This arrangement not only ensures secure fastening of the cylinders but at the same time facilitates their easy replacement. Apart from that, the risk of crack is eliminated, which may be implied in welded joints of cylinders and webs. This avoids costly repairs and downtimes.

GENERATING VIBRATION. The drive is carried in the centre of the robust web. The major drive components are two cylindrical roller bearings, the drive shaft and two pairs of unbalanced weights. The latter are easily accessible and can be quickly adjusted relative to each other in very small steps. Consequently there is no difficulty in accurately matching the diameter of the vibrating circle to the feed material, thereby achieving optimum size reduction. The roller bearings of high load-carrying capacity have been fastened in the webs in such a manner that the complete unbalanced drive can be easily removed for inspection or repairs. The squirrel cage motor which drives the mill has been mounted on a bracket at the front of the machine. It is connected directly to the shaft of the front unbalanced drive via a cardan shaft. The drive is of such design that no axial forces act on the mill bearings. The motor can be set up at either end of the machine.

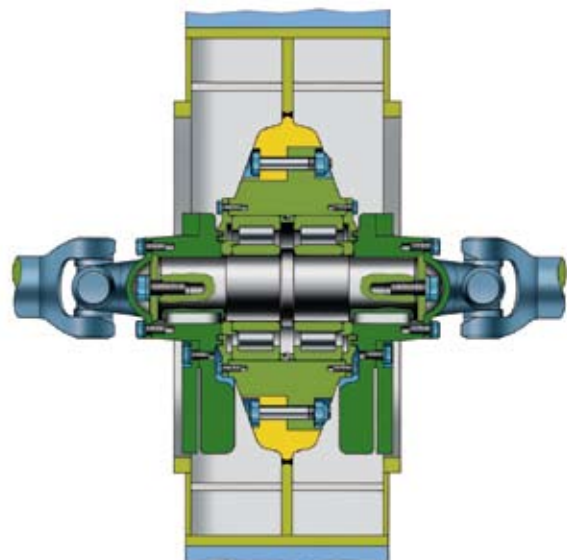
ELECTRIC CONNECTION. Electric connection and circuit connection of the motor depend on the local regulations and local capability of the supply network. The motor should be laid out so that the starting torque equals at least 2,2 times the rated torque. The direction of rotation of the motor is optional. Alternating operation will considerably extend the service life of the cylindrical liners. Mill operation can be monitored with aid of an ammeter which indicates the power consumption of the motor.

THE REPLACEABLE BEARINGS SEATS FOR PALLA 50U/PALLA 65U. Along with advantages in the design of our PALLA U Vibrating Mills, the cylindrical bearing assembly of the PALLA 50U and PALLA 65U has been significantly improved.

The roller bearing assemblies are carried in replaceable bearing bushes screwed to the webs of the grinding mill and transmitting forces exclusively by way of static friction. This new feature allows simple, fast and cost-effective elimination of damage at the bearing seat, caused e. g. by faulty operation, simply by replacing bushes. Consequently the web does not require replacement and the mill therefore does not have to be dismantled.

INSULATION. Vibration isolation by means of the elastic elements means that the relatively small dynamic forces are transmitted from the vibrating machine to the supports. Therefore, special foundations are hardly ever required. Even strict isolating requirements can be met also in case of adverse site conditions by using a foundation with precisely calculated damping mass.

When installing vibrating mills in open buildings or in close vicinity to working areas, it is recommended to have them enclosed for sound abating.



Bearing unit

GRINDING CYLINDER CONNECTION. The following options for the connection of the grinding cylinders for grinding process are possible.

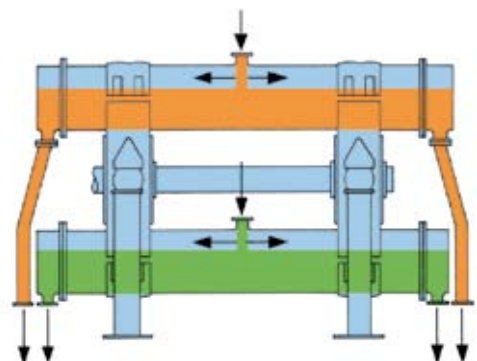
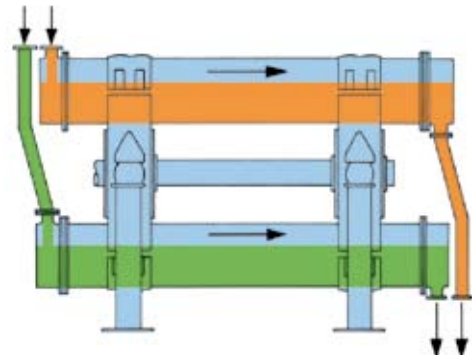
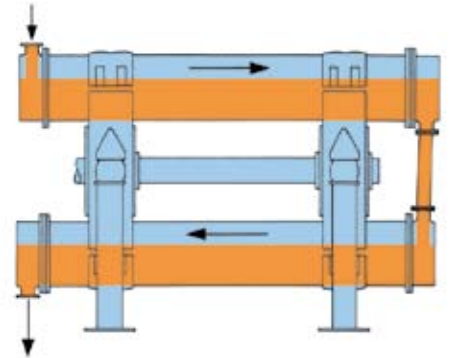
Series connection: With this type of arrangement, the feed passes both grinding cylinders successively, with results in maximum grinding path lengths and longest retention times of >12 minutes.

This connection is applicable for fairly hard or coarse feed, for very fine end products, for materials which are characterized by poor blending properties, or for long grinding, dissolving and reaction processes.

Parallel connection: With this arrangement, either cylinder yields a finished product and shorter retention times of 3–12 minutes and higher throughput rates can be achieved. Identical or different materials can be ground, blended or chemically treated in the two cylinders at the same time.

This arrangement is suitable for materials that are easy to grind, for closed circuit grinding, for simple blending operations and dissolving processes as well as for chemical reactions of short duration.

Centre feeding: In this configuration the material flows in either direction towards the outlet caps. Grinding path and retention time are very short and the throughput is correspondingly high. Size reduction is less than under series or parallel connection. This arrangement is suitable for soft materials requiring minor grinding only or any other substance to reach a product as coarse as possible, for quick chemical reactions or for dissolving processes.





SPECIAL DESIGNS. Due to the application of PALLA in so many different branches of industries, the vibrating mill sometimes requires a special design.

The PALLA can be constructed and installed in a vertical or horizontal design, whereas the vertical is more common because of its smaller footprint.

The CRYOPALLA is a time-proven machine for grinding of metals or other materials which are difficult to grind at normal temperatures. In a CRYOPALLA the feed material is brittle by cryogenic agents down to -185°C and then reduced in size. Due to its special design this grinding mill enables cost-effective grinding at low temperatures.

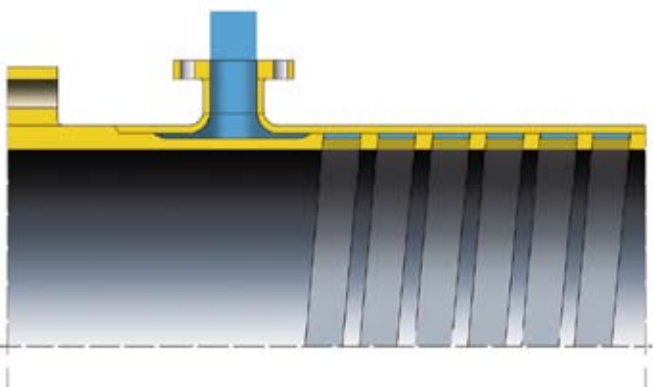
The PALLA EX generates, a combination of elliptical, circular and linear vibration. This ensures an efficient circulation of the grinding media and grinding material with a positive degree of aeration and generates in addition to the impact forces, also friction. There is less accretion of very soft products at the grinding media and the grinding walls.

Furthermore double-walled cylinders are used which enable cooling or heating with water or brine in order to maintain a given material temperature.

Our focus is the flexible and optimal realisation of our client wishes regardless of the complexity.



Horizontal PALLA
CRYOPALLA
Grinding cylinder – water cooled design





Our company-owned R&D centre is an important body between theory and practice. Since for most materials the grindability is unknown, milling tests are normally required prior to the design of a vibrating mill. Laboratory scale test works are carried out in order to verify the different machine parameters of dimensioning the PALLA and all other crushing, grinding and sorting equipment. Estimating the throughput for each material requires milling tests in which different parameters like frequency, amplitude of vibration, arrangement of grinding cylinders and grinding media are determined. The optimal mill design depends on the application, material properties, feed and product grain size, size distribution as well as grain shape and surface.

The test works are executed in a laboratory scale, vibrating mill for dry and wet grinding. The results can be upscaled to any vibrating mill size. Small sample quantities of different feed materials allow rapid and economic pulverisation and extrapolation.

Feed and product grain size analysis can be offered whether with air-jet sieve, wet screening or laser granulometer.



RESEARCH AND DEVELOPMENT CENTRE

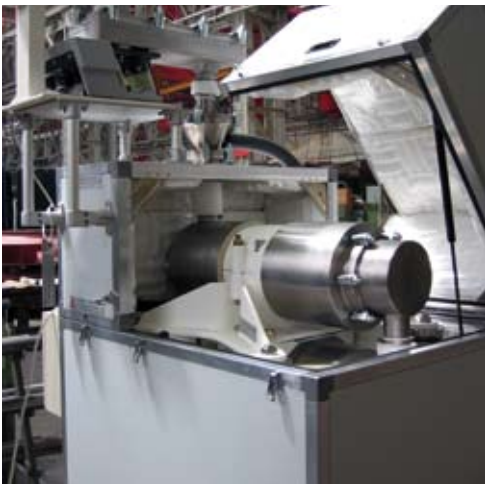


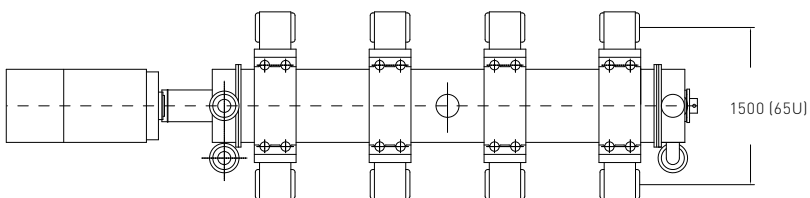
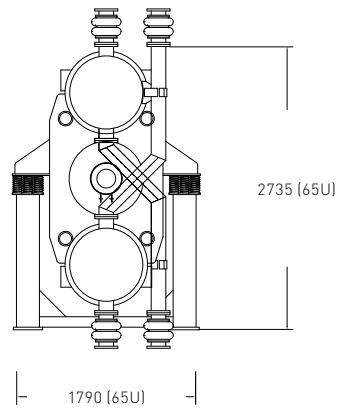
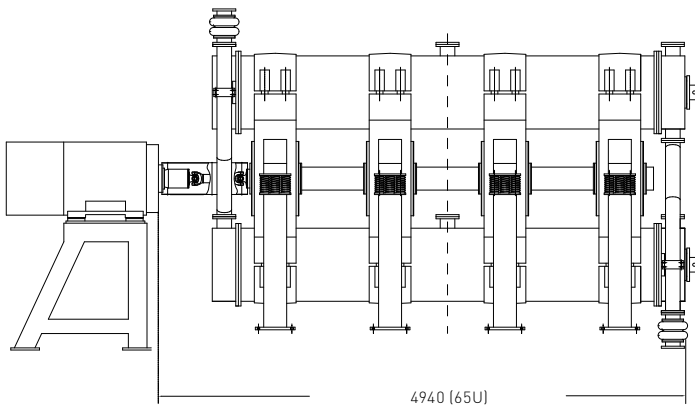
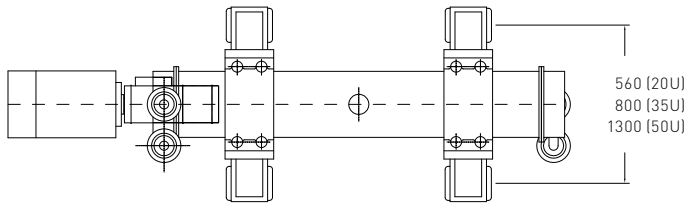
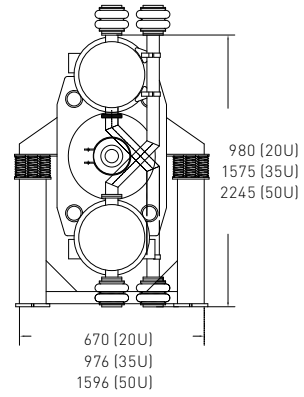
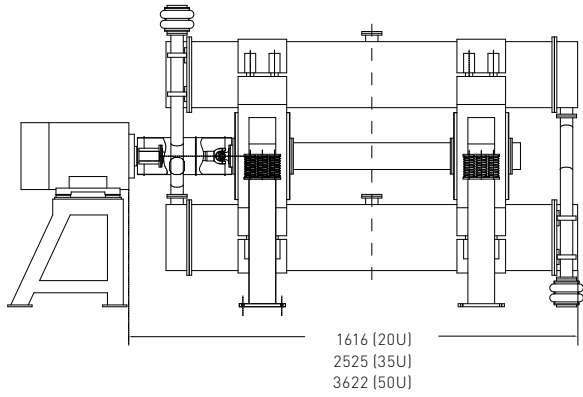
PALLA VM. The results obtained can be transferred without restriction to industrial scale systems. Three different types are offered, i. e.:

VM-S. Enabling individual tests for rapid process optimisation at low expenditure and with small material quantities (approx. 1–2 kg).

VM-K. Designed for short- and long-term tests (up to 100 kg/h – depending on feed properties) for process optimisation.

VM-KT. Permitting tests as detailed as for type VM-K above but for temperatures down to -185°C .







SCOPES OF SERVICES

AFTER-SALES SERVICE. Utilising our considerable logistical, engineering and site service expertise, MBE Coal & Minerals Technology GmbH aim to provide an unparalleled level of ongoing services. These services will maximise the operators' return on their investment throughout the lifetime of the equipment.

We believe that strong partnerships can only evolve with personal contact. From the outset we have assigned an Account Manager who will learn about your business and understand its unique demands. Utilising that knowledge and by focussing on what is important to each individual customer, we can develop an operational plan that will ensure we deliver on our promises – on time and within budget.

The four key services we offer to maintain and improve the operation of your equipment:

- competitively priced OEM spare parts with lead times to meet the customers' operating requirements
- we carry out planned service visits at mutually agreed intervals with an optional emergency call-out service and operator training
- upgrade packages for your equipment to improve performance, based on our most recent product developments
- equipment refurbishment

Continue to utilise our people and expertise to maximise the efficiency of your operations. "We will not let you down."

FROM THE FIRST STEP UP TO THE COMMISSIONING. To realise your projects you can receive the entire scope of services from one source, i. e. from us:

Project consulting by globally experienced mining, process, mechanical engineers and mineralogists.

Test work in our own R&D centre and laboratories.

Feasibility studies in joint effort of clients' personnel familiar with the project targets and our competent employees, even up to project financing.

Plant design with basic and detail engineering including project management.

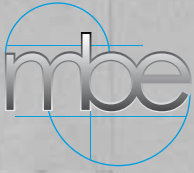
Supply of equipment, systems and plants.

Training of end users' personnel for management functions same as for operators and maintenance employees, in our offices, in our R&D centre, in our reference plants all over the world, and finally on end users' site.

Installation/supervision of installation of our equipment and systems by or own globally experienced service specialists.

Commissioning of equipment, systems and plants.

After-Sales services including not only supply of parts and respective services but also consultancy in respect of operation and maintenance of our equipment.



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