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informative and non-binding.  
Our quotations are authoritative with regard  
to orders.

## SUPER-ORION® BALL MILL

TYPES S.O., S.O.-CL COMPACT LINE, S.O.-SF SUPER FINE



### HOSOKAWA ALPINE Aktiengesellschaft

Hosokawa Alpine is a member of the Hosokawa Micron Group, responding to global needs through emphasis on materials science and engineering. The Group is an international provider of equipment and technology for powder and particle processing, plastics processing and confectionery products. The Group maintains facilities for research, engineering, manufacturing and service in each of the world's major industrial markets.

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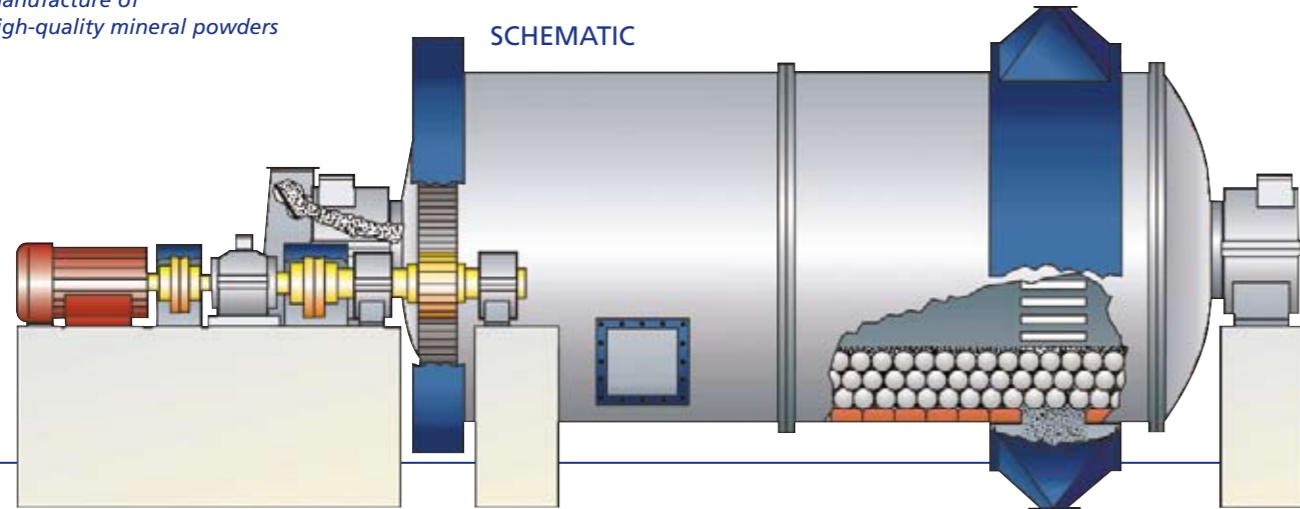
## HOSOKAWA ALPINE

PROCESS TECHNOLOGIES FOR TOMORROW<sup>SM</sup>

**SUPER-ORION BALL MILL S.O. A FLEXIBLE CONCEPT**



A flexible concept: ball mills have been the mill of choice for many years for the manufacture of high-quality mineral powders



**PRINCIPLE OF OPERATION**

Regardless of whether the feed material has a Mohs' hardness value of over 4 or is a soft mineral such as limestone, talc or baryte - which would nevertheless cause a high degree of wear in high-speed mills because of hard and abrasive constituents - Super-Orion ball mills ensure low-wear and cost-effective processing. We have continuously improved the ball mill over the years from a simple machine for the industrial minerals sector to a high-tech machine for the mineral powder industry. The original milling principle and the unparalleled robustness of the machine have not changed. Today, there are three different standard designs available.

Ball mills are giant drums that are filled to between 30 and 40% of their volume with freely moving milling media - in this case balls. The diameter of the balls is between one and several centimetres to suit the application - smaller balls for fine milling results and larger ones for coarser milling tasks. The drive sets the milling drum into slow rotation and the bed of milling media is thus activated, i.e. the balls are lifted and then impact back against the bed.

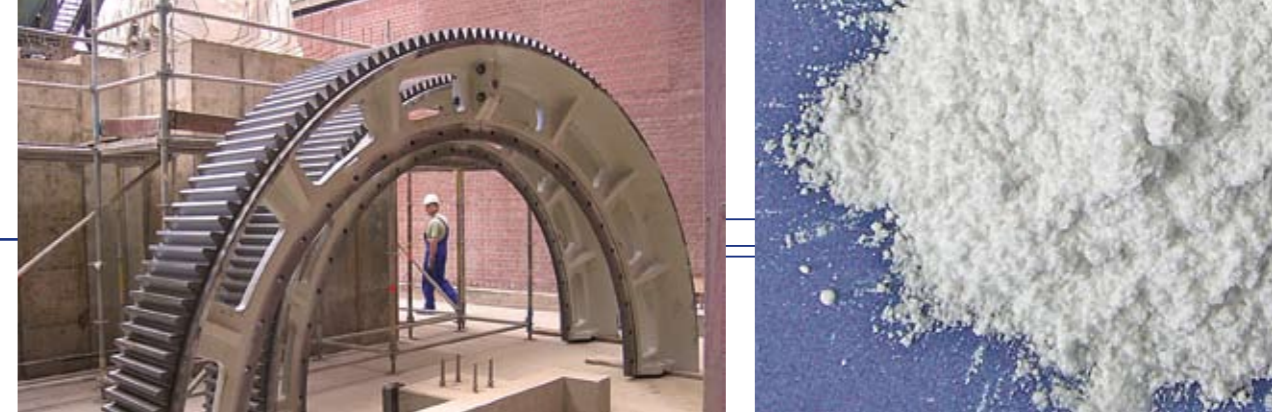
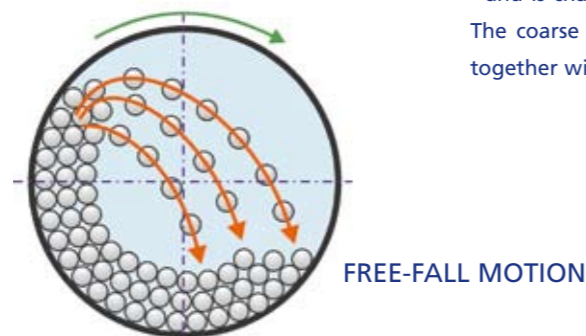
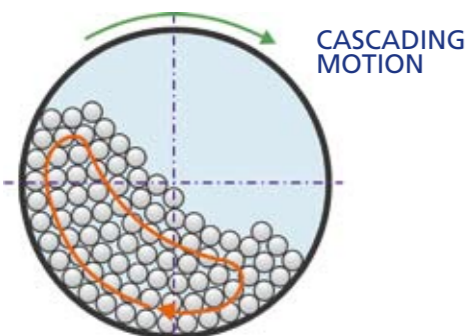
Ball mills are usually operated at 75% of the critical speed. The critical speed is the speed where, mathematically calculated, the

grinding media would centrifuge out, and can be described as follows:

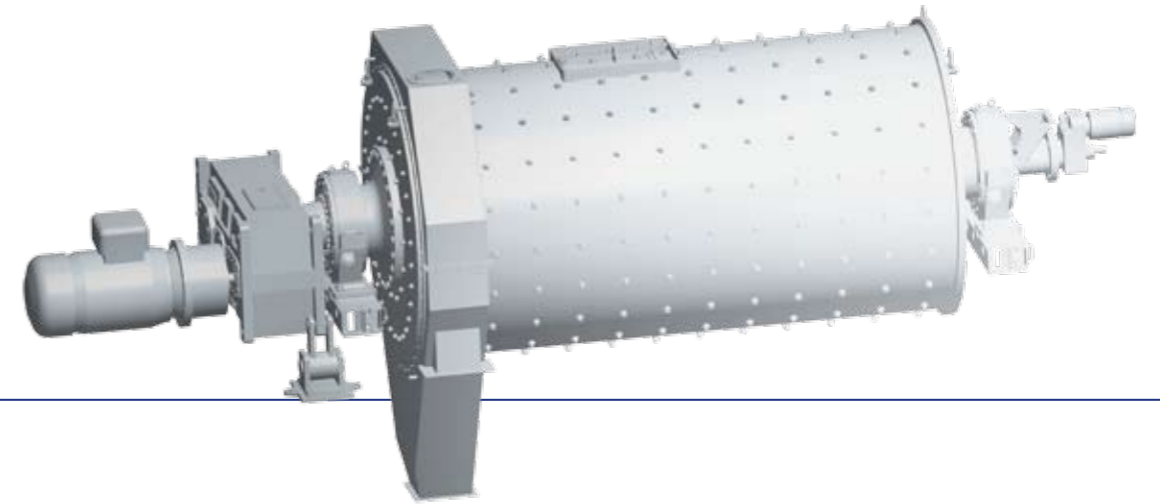
$$n_c [1/min] = 42,3 / \sqrt{D [m]}$$

Mills of 2 m in diameter therefore rotate in operation at about 23 revolutions per minute, which corresponds to a peripheral speed of 2.4 m/s. A mill of this size equipped with steel milling media converts approx. 50 kW per m<sup>3</sup> of feedstock.

The feed product is fed continuously through the trunnion and is discharged through slots on the opposite side. The discharge rate can be adjusted as a function of the number of open slots. The ground product is transported - often pneumatically - and is charged to a downstream classifier. The coarse material is returned to the mill together with the feed product.



**BALL MILL S.O., S.O.-CL AND S.O.-SF**



**SUPER-ORION S.O. FEATURES**

- The classic standard design, which has proved itself in operation throughout the world for decades.
- Both the design and efficiency are continually improved to pay tribute to new technology and market requirements.
- Cast side plates bolted to a rolled-steel drum with integrated manhole
- Drive via ring-and-pinion gear with automatically controlled tooth lubrication, back gearing with couplings and high-performance gear unit
- Bearing unit: journal bearing designed as a friction bearing with permanent oil-recirculation lubrication and temperature control
- Option: self-aligning roller bearing
- Product discharge via adjustable slots located around the periphery of the drum. Two-part discharge housing with top venting connection and inspection cover

**SUPER-ORION S.O.-CL (COMPACT LINE) FEATURES**

- Milling drum of high-grade steel completely in welded design
- Direct drive via trunnion with top-mounted gear unit. Direct motor-gear unit connection via flanged motor
- Drive shaft and trunnion supported in enclosed anti-friction bearings
- Product discharge via slots located around the periphery of the drum
- Mill start-up controlled via frequency converter
- Nominal mill speed can be varied by ± 5% via frequency converter

**SUPER-ORION S.O.-SF (SUPER FINE) FEATURES**

- High-tech mill for manufacturing ultrafine fillers and ceramic materials with  $d_{97} < 10 \mu m$
- Fineness down to  $d_{50} = 0.8 \mu m$
- Design as for S.O.-C.L. above, albeit with slotted panel to separate milling media from the product in the discharge area
- Special milling media
- Option: mill on load cells



## SUPER-ORION S.O. WITH STEEL GRINDING MEDIA AND STEEL LINING FOR FILLERS



The ball mill continues to be the most popular machine when it comes to manufacturing mineral fillers, and is characterised by:

- Low maintenance costs
- Extremely long service life (over 50 years)
- High degree of robustness

An important decision criterion for using a ball mill as the principal size reduction machine is its enormous flexibility in the ultrafine range. With the Super-Orion ball mill, fine products such as paper fillers in coating quality ( $d_{80} = 2 \mu\text{m}$ ) as well as coarse fillers, e.g. dolomite powder for bitumen fillers ( $d_{97} = 100 \mu\text{m}$ ) can be produced.

Examples of mineral fillers:

- Limestone, chalk, marble
- Dolomite
- Kaolin, calcined kaolin, bentonite
- Talc
- Baryte

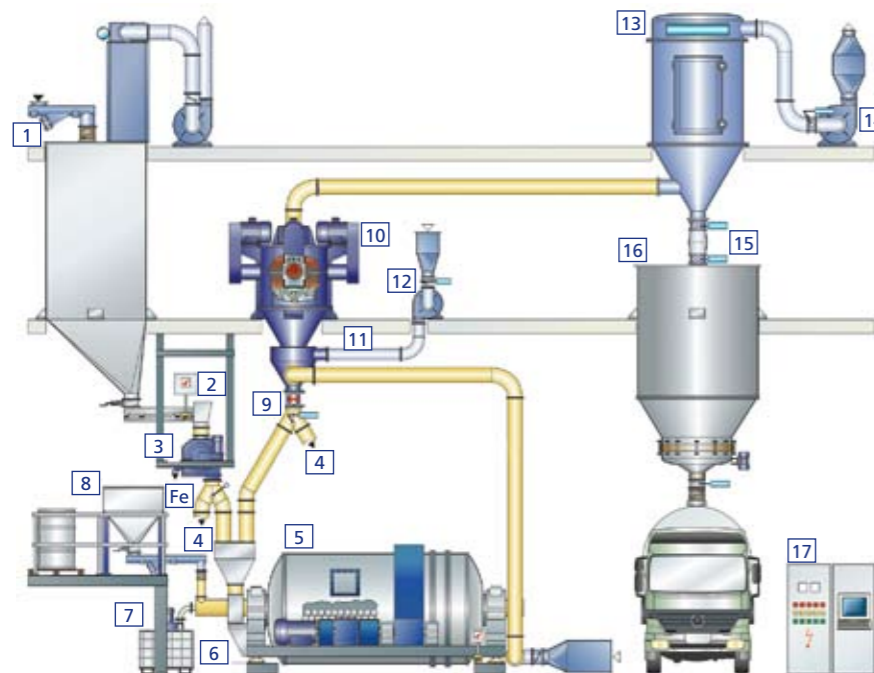


Machine size with steel milling media and steel lining	125/125	125/160	160/160	160/200	160/270	160/330	160/400	200/270	200/330	200/400
S.O.			■	■	■	■	■	■	■	■
S.O.-CL	■	■	■	■	■	■	■	■	■	■
with slotted panel S.O. - SF	●	●	●	●	●	●	●	●	●	●
Motor kW	22	37	55	75	90	110	132	160	200	200
Throughput t/h Limestone $d_{70} 2 \mu\text{m}$ Classifier ATP-NG	0.1	0.15	0.25	0.3	0.4	0.5	0.6	0.6	1.0	1.2
Throughput t/h Limestone $d_{97} 10 \mu\text{m}$ Classifier ATP	200	315	315	400	500	500	315/3	315/3	315/6	315/6
Throughput t/h Limestone $d_{97} 40 \mu\text{m}$ Classifier ASP	0.7	1.0	1.8	2.3	3.1	3.8	4.6	5.4	6.6	8.0
	315	315	315	315	400	500	630	630	630	800

Machine size with steel milling media and steel lining	230/400	230/500	270/400	270/500	270/600	300/500	300/600	300/700	400/500
S.O.	■	■	■	■	■	■	■	■	■
S.O.-CL	■	■							
with slotted panel S.O. - SF	●	●	●	●	●	●	●	●	●
Motor kW	315	355	450	560	710	710	900	1000	1400
Throughput t/h Limestone $d_{70} 2 \mu\text{m}$ Classifier ATP-NG	1.5	1.9	2.2	2.8	3.3	3.6	4.4	5.1	7.5
Throughput t/h Limestone $d_{97} 10 \mu\text{m}$ Classifier ATP	500/3	500/4	2 x 315/6	2 x 500/3	2 x 500/4	2 x 500/4	3 x 500/3	3 x 500/4	4 x 500/4
Throughput t/h Limestone $d_{97} 40 \mu\text{m}$ Classifier ASP	3.2	4.1	4.9	6.1	7.3	8.0	9.5	11.1	15.5
	500/3	500/4	500/4	630/4	630/4	630/4	2 x 500/4	500/4 630/4	2 x 630/4
	11.5	14.3	17	21	26	28	33	37	46
	1000	1000	1250	1250	1500	1500	1500	1800	1800

The values in the table are based on production runs with medium-hard limestone. This information is purely informative. Guaranteed values only possible after trials have been conducted with the original feed material. The values refer to mills operated in circuit with

■ available sizes  
● option



- 1 Feed silo with metering and dedusting
- 2 Weighbelt feeder
- 3 Magnetic separator
- 4 Sampling port
- 5 Ball mill S.O.
- 6 Load cells
- 7 Milling aid inlet
- 8 Milling media inlet
- 9 Rotary valve
- 10 Ultrafine classifier ATP
- 11 Secondary air inlet
- 12 Pneumatic butterfly valve
- 13 Automatic reverse jet filter
- 14 Fan
- 15 Pneumatic flap valve
- 16 End-product silo mit activated discharge and shut-off element
- 17 Control cabinet

Even ultrafine products are manufactured direct in the mill/classifier circuit, i.e. the entire coarse fraction from the classifier is returned to the mill. This helps to prevent waste or coarse materials for which there is little market demand. Our mills for fillers are lined with high-grade steel which

is optimally matched with the low-wear steel milling media. Selection of the milling media is a function of the feed material and of the desired end product, whereby state-of-the-art scientific findings and calculation methods are applied. The use of highly wear-resistant materials prevents discoloration,

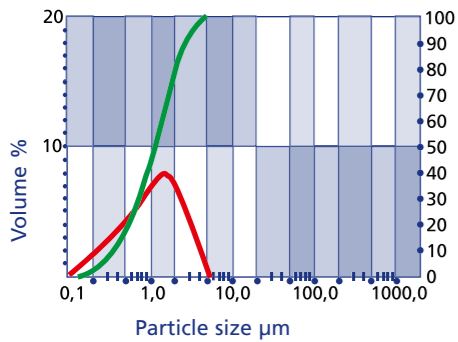
which is a frequent requirement for top-quality fillers used in plastics, paints or paper. Even minor impurities or abrasive constituents in the feed material do not adversely affect the milling process.

**SUPER-ORION S.O. FOR TECHNICAL CERAMICS AND CERAMIC RAW MATERIALS (AL<sub>2</sub>O<sub>3</sub>, ZrO, ZIRCONIUM SILICATE, ETC.)**



ALUMINIUM OXIDE MILLING BEADS

ALUMINIUM OXIDE CYLPEBS



The Super-Orion ball mill has also proved itself in operation around the world for processing ceramic raw materials. In combination with a classifier, the ball mill usually forms the heart of the process. In spite of ceramic raw materials with a Mohs' hardness of between 5 and 8 being extremely abrasive, milling must be performed without iron contamination if the colour integrity of the end product is to be ensured. Because of this, the ball mill is usually lined with aluminium oxide and operated with Al<sub>2</sub>O<sub>3</sub> milling media.

Not only is a lined ball mill necessary for processing without iron contamination, but the classifier must also be suitably protected against wear. As a result, the product-contact parts of all suitable classifier models such as Turboplex, Stratoplex and Ventoplex are protected against wear with ceramic or PU. Particular attention must be paid to the classifying wheel because wear increases with the square of the speed (double the speed = four times the wear). In view of this, ATP Turboplex classifiers are equipped with monobloc ceramic classifying wheels..



Machine size with alu-oxide milling media and alu-oxide lining	155/155	155/195	155/365	195/195	195/265	195/325	195/395	195/495	225/395	225/495
S.O.	■	■	■	■	■	■	■	■	■	■
S.O.-CL	■	■	■	■	■	■	■	■	■	■
with slotted panel S.O. - SF	●	●	●	●	●	●	●	●	●	●
Motor kW	30	37	55	55	75	90	110	132	132	160
Throughput t/h of zircon sand d <sub>50</sub> 1 μm Classifier ATP							0.15	0.25	0.3	0.35
							315	200/4	315/3	315/3
Throughput t/h of aluminium oxide d <sub>50</sub> 2 μm Classifier ATP	0.1		0.2				0.6		0.9	1.1
	200		315				315/3		315/6	315/6
Throughput t/h of quartz sand d <sub>97</sub> 40 μm Classifier ASP				0.7	0.9	1.1	1.4	1.6	1.9	2.5
				315	315	315	315	315	400	400
Throughput t/h of feldspar d <sub>97</sub> 63 μm Classifier ASP				0.7	1.0	1.2	1.5	1.7	2.0	2.6
				315	315	315	315	315	315	400

Machine size with alu-oxide milling media and alu-oxide lining	225/595	265/495	265/595	295/495	295/595	295/695	395/395	395/495	395/595	395/795
S.O.	■	■	■	■	■	■	■	■	■	■
S.O.-CL	■	■	■							
with slotted panel S.O. - SF	●	●	●	●	●	●	●	●	●	●
Motor kW	200	250	315	355	450	500	630	710	900	1120
Throughput t/h of zircon sand d <sub>50</sub> 1 μm Classifier ATP	0.4		0.6	0.7	0.8		1.0	1.4	1.6	
	315/3		315/6	315/6	315/6		2 x 315/6	2 x 315/6	2 x 315/6	
Throughput t/h of aluminium oxide d <sub>50</sub> 2 μm Classifier ATP				2.1		3.0				
				2 x 315/6		3 x 315/6				
Throughput t/h of quartz sand d <sub>97</sub> 40 μm Classifier ASP	2.9	3.6	4.4	4.8	5.7	6.7	7.8	10.0	12.0	16.0
	500	500	500	630	630	800	800	1000	1000	1250
Throughput t/h of feldspar d <sub>97</sub> 63 μm Classifier ASP	3.1	3.9	4.7	5.1	6.1	7.1	8.3	10.4	12.5	16.8
	400	500	500	500	630	630	630	800	800	1000

The values in the table below are based on production runs with zircon sand, aluminium oxide, quartz sand and feldspar of medium grindability. This information is purely informative. Guaranteed values only possible after trials have been conducted with the original feed material. The values refer to mills operated in circuit with suitable classifiers.

■ available sizes  
● option

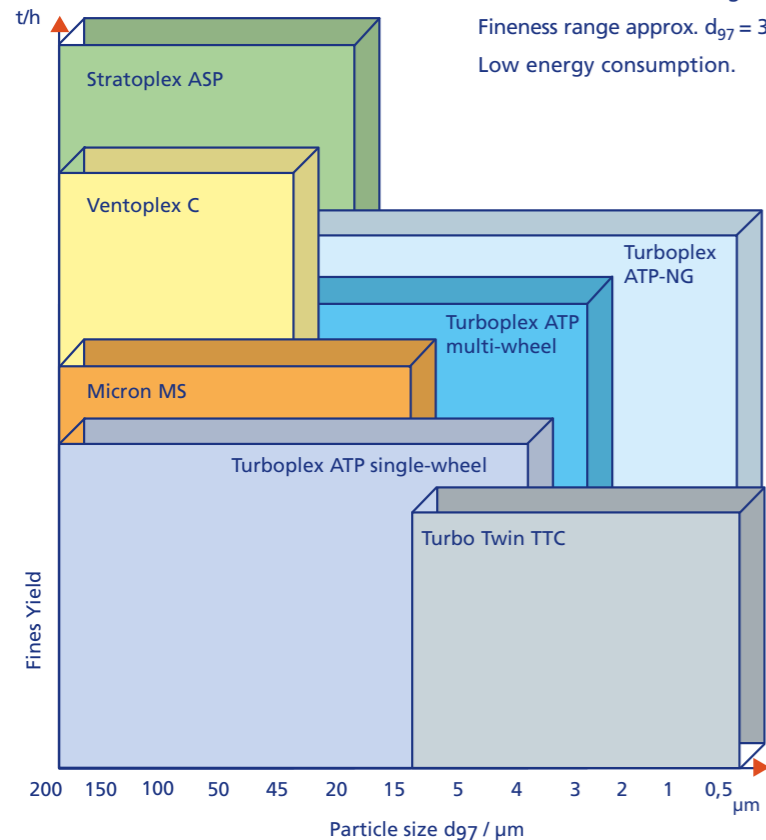


**TURBO-TWIN CLASSIFIER TTC**

Since the Alpine Mikroplex spiral air classifier MP was launched on the market in 1948, Hosokawa Alpine has been extremely successful classifiers

We offer system configurations for a great variety of products and fineness ranges that are optimally tailored to the individual application in each case. The following classifiers are eminently suitable for closed-circuit operation with a ball mill.

**VENTOPLEX CLASSIFIER C**  
Circuit-air classifier for high throughputs. Fineness range approx.  $d_{97} = 32 \mu\text{m} - 200 \mu\text{m}$ . Low energy consumption.



**MICRON AIR CLASSIFIER MS**  
Ultrafine classifier designed as an air-flow classifier (pneumatic product feed). Operating range: approx.  $d_{97} = 15 - 150 \mu\text{m}$ . High throughput rates.

**STRATOPLEX AIR CLASSIFIER ASP**  
Standard classifier for high throughput rates in the fine to medium-fine separation range of  $d_{97} = 20 - 200 \mu\text{m}$ . High fines yield at low energy consumption.

**TURBOPLEX ULTRAFINE CLASSIFIER ATP AND ATP-NG**  
Single- or multi-wheel classifier for ultrafine classification. Superfine powders in the range  $d_{97} = 3 - 10 \mu\text{m}$ . In NG design, fineness values to  $d_{97} = 2 \mu\text{m}$  ( $d_{50} = 0,5 \mu\text{m}$ ) are possible. Operation free from oversized particles over the entire separation range. Integrated coarse material classifier to increase the yield.

**TURBO-TWIN CLASSIFIER TTC**  
New classifying concept for results in the fineness range to  $d_{50} = 0,5 \mu\text{m}$ .



Ball mills are usually operated at 75% of the critical speed, i.e. in the fringe area between cascading and free-fall motion.

### VARIABLE-SPEED DRIVE

With a special frequency converter version, it is even possible to operate a heavy ball mill at variable speed. And if the S.O.-SF is to be used for milling ultrafine products or if it is planned to change the product often, operation with a frequency converter is particularly advantageous.

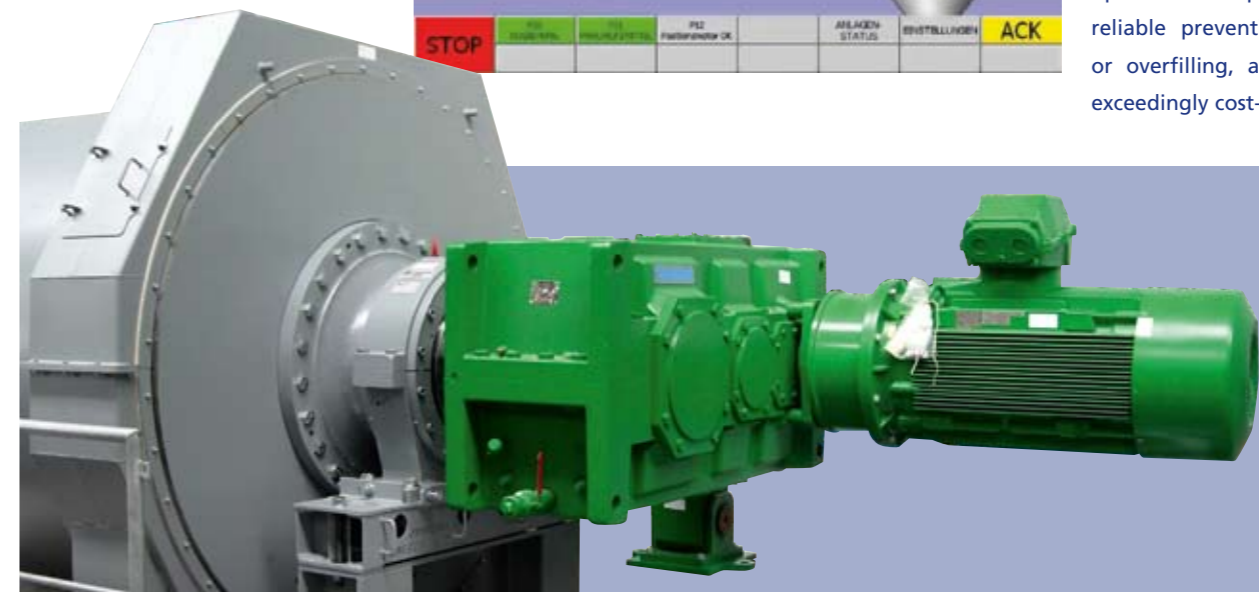
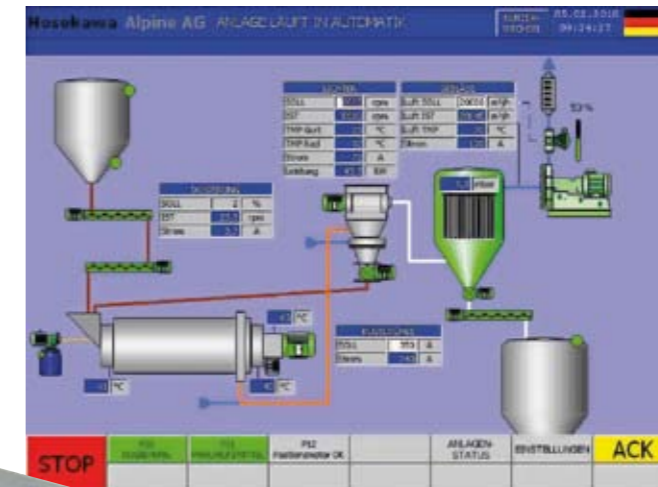
### LOAD CELL TECHNOLOGY RESULTS IN PRECISION PRODUCT LEVEL CONTROL

Modern applications call for exact measurement of the amount of product in the mill. Because of this, an optional accessory offered for our ball mills is the load cell system. This system works with a tolerance of  $\pm 25$  to 50 kg (dependent on the mill size), and permits high-precision

control and metering via a screen. The user therefore has the possibility of entering and monitoring up to 4 individual limit values direct on screen or via a bus or serial 20-mA TTY interface.

The complete ball mill is bedded on a steel or concrete frame designed to rest on a defined number of load cells. The load cells are integrated into a control unit and determine the total weight of mill, grinding media and product. Subtracting the weight of mill and milling media results in the weight of the product in the mill. This is accomplished with leading-edge electronics in the kg measuring range.

The addition of virgin feed can be controlled with such precision that the mill always operates at optimum load. This means reliable prevention of no-load operation or overfilling, and mill operation is thus exceedingly cost-effective.





*The more demanding the task,  
the more you benefit from our  
comprehensive range of services*

### CONSULTING SERVICES

Problem specification, exploration of different technical solutions, product-specific processes, consideration of safety aspects, different system concepts, e.g. pressure-shock-proof, inert gas mode, CIP/SIP, etc.

### TRIALS

Milling and classifying trials, laboratory analyses, determination of energy requirements and production costs, manufacture of product samples, rental systems.

### ENGINEERING

Initial design stage:  
conceptual studies – basic engineering, flowcharts – installation planning; safety concepts, e.g. ATEX; project documentation  
Detail planning:  
P&I diagrams; calculation and layout; specification of components; design, programming and networking of visualisation systems; structural steel engineering with static calculations; planning the piping and ductwork; official acceptance of subcontractor work.

### PROCESS AUTOMATION

Control cabinets, conventional control units (Plexwire), process control with PLC, visualisation systems, process data archiving, logic diagrams, teleservice connection for remote maintenance.

### DOCUMENTATION

- Operating instructions, operating manuals
- "As built" documentation
- Software documentation
- Documentation as per 21 CFR Part 11 for the pharmaceuticals industry
- CE certification

### MANUFACTURING

Areas of competence:

- CNC autogenous and plasma flame cutting.
- Manufacture of pressureless and pressure-shock-proof welding subassemblies in different material qualities by qualified machinists and welders
- CNC processing of complex components using turning, drilling, milling and grinding.

### ASSEMBLY

- Assembly of complicated subassemblies and machines of different design and dimension
- Design consultancy in all manufacturing issues
- Test runs, factory acceptance tests (FAT)

### ENGINEERING PLANNING AND SUPERVISION

- Project coordination
- Installation and assembly of complete systems on the customer's premises by competent field service engineers all over the world
- On-site supervision

### COMMISSIONING

- Commissioning, training, test runs, site acceptance tests (SAT)

### TOLL MILLING

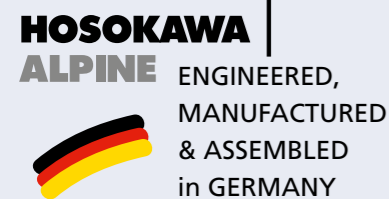
Our affiliated company, Hosokawa Micron Powders GmbH in Cologne, offers a wide range of toll processing services. We would be glad to give you the contact details.



With a floor area of 3000 m<sup>2</sup> spread over 4 stories, the Hosokawa Alpine application testing centre in Augsburg is one of largest testing centres in Europe dedicated to the wet and dry processing of products in powder form.

With over 60 state-of-the-art machines and complete systems on both a production and laboratory/pilot scale as well as the associated testing laboratory, we offer you the most comprehensive range of testing possibilities aimed at optimum system layout and determination of process-related guaranteed values.

The 20-strong team in the testing centre is made up of test engineers, laboratory technicians, system assistants and mechanics, is fully conversant with the technical characteristics of every system and has a great deal of experience in handling a wide variety of different products.



### MADE IN GERMANY

A high-quality product calls for competence in development, engineering, manufacture and assembly. And this competence in turn stems from the training, know-how, experience and motivation of the company staff. The environment of the company headquarters in Augsburg has always fulfilled these requirements in the best possible way. And it is here that we find the dedicated and excellently trained staff who render a great service to the company, the products and the success of our customers.

For this reason and in the tradition of our own self-imposed commitment to high quality, we will continue to lay store by Germany as a business location. The new emblem for our letterheaded company paper with the message ENGINEERED, MANUFACTURED AND ASSEMBLED IN GERMANY underlines this commitment.