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with regard to orders.

## ALPINE AGITATED BALL MILL AHM WET MILLING DOWN TO THE NANO RANGE



### 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>

## AGITATED BALL MILL AHM



An agitated ball mill with a horizontal, cylindrical milling chamber that is universal in use for the continuous wet milling of particles down to the submicron range.



The AHM agitated ball mill was specially developed for suspensions with good flow properties where a steep particle size distribution and high end-product fineness are demanded. The mill is suitable for both continuous operation and for batch mode in the case of closed-circuit milling.

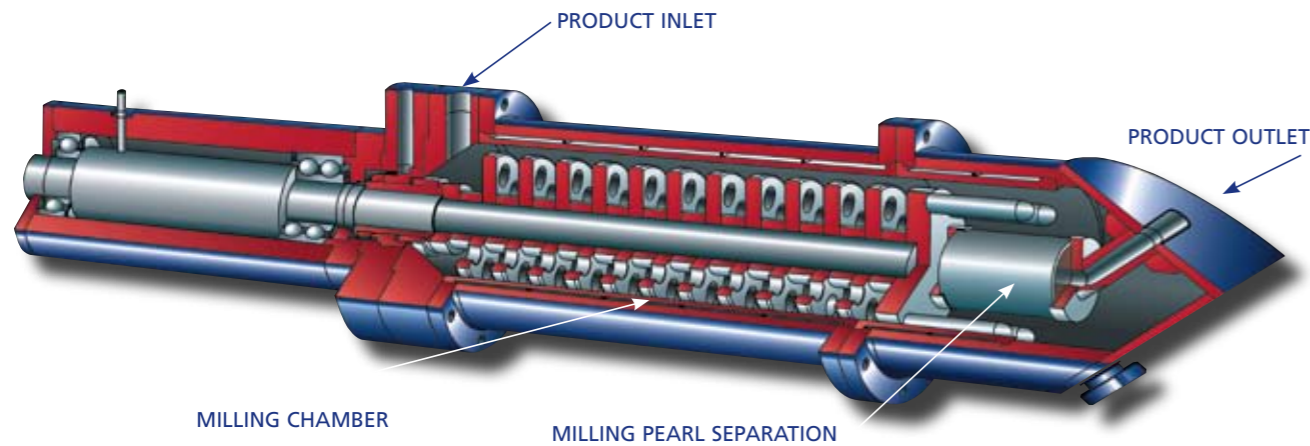
The AHM is available in sizes suitable for the laboratory, the testing centre or for large-scale production. Alpine thus offers a complete product line to cover this range of processing tasks.

### PRINCIPLE OF OPERATION

Size reduction of the particles takes place in a liquid with the aid of a bed of agitated milling beads. In continuous mode, the product is pumped into the mill, it flows through the agitated bed of milling beads and exits the mill through a screening element located at the end of the milling chamber. Approx. 70-80% of the mill volume is filled with milling beads.

### APPLICATIONS

Chemicals, minerals, PCC, ceramics, foodstuffs, metals, pigments, paints (mass production), laboratory, nano particles, abrasives, pharmaceuticals.

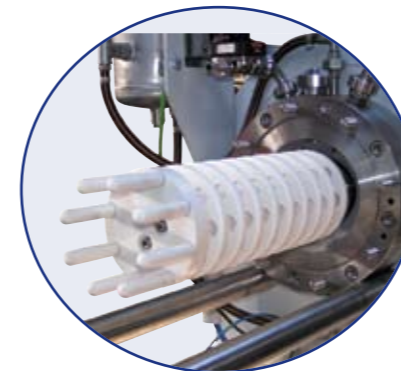


### HANDLING

The large mills are equipped with stationary or mobile service units that guarantee simple dismantling for cleaning and maintenance. There is sufficient space underneath the milling chamber to permit the use of large-volume collection bins for emptying and cleaning the mill.

The slotted screen separation element is low-wear in design and is installed in the mill axis. It comprises a screen holder and a slotted pipe screen which can be exchanged easily and quickly without having to empty the mill. Rotating stirrers in the separating zone relieve the screen dynamically and prevent blockages.

A robust, double-action mechanical seal with sealing-liquid unit guarantees a high level of operating reliability.



### WEAR PROTECTION

The AHM has a cylindrical, double-walled mill housing that can be cooled. The inside of the milling chamber is lined using liner pipes in either hardened stainless steel or polyurethane. This modular concept enables rapid exchange of the lining and offers such advantages as inexpensive spare parts and flexible application possibilities.

The material of construction for the agitator discs, separating rings and stirrers is selected to suit the individual application. Because of this, a long service life can be achieved even if abrasive suspensions are processed. Again, the individual components have been designed with flexibility and cost optimisation in mind.

When extremely high demands are placed on the products with regard to contamination, the rotor and stator parts can be coated with either high-grade ceramics or tungsten carbide.



### DESIGN

- Coolable housing
- Explosion-protected

Milling tools and linings made of:

- Polyurethane
- Hardened alloy casting
- Stainless steel
- Ceramic (small machine sizes only)

Product	Feed size $d_{97}$ in $\mu\text{m}$	End fineness $d_{97}$ in $\mu\text{m}$	End fineness $d_{50}$ in $\mu\text{m}$	Spec. milling energy kWh/t
Fungicides	100	10	2.2	150
Limestone (PCC)	90	1.4	0.7	320
Food colouring	80	3	1.5	650
Silicon nitride	45	2.5	0.9	490
Zirconia	52	1.3	0.5	430

AHM type	90	132	200	315	400	475	630	800
Milling chamber l	0.25-1.1	5	17	65	132	221	516	1056
Motor kW	2.2	7.5	22	45	75	110	200	316

LABORATORY WET MILL  
90 AHM, 132 AHM



The 90 AHM is the laboratory version in the AHM product line and is designed as a table-top model with separate control unit

This mill is suitable for small amounts of product and for development trials - also on the nano technology sector.

Extremely small milling beads (< 0.2 mm) can be employed with this mill, and investigations regarding the stabilisation of suspensions in the submicron range can be executed.

OPERATING PRINCIPLE

In contrast to the other AHM mill types, the laboratory version has a variable-speed direct drive (2.2 kW / 4000 rpm). The slotted-hole screen has the shape of a pipe and is dynamically relieved by a specially designed rotor. The mill can be tilted on a pivoted support to permit filling and emptying. When in upright position, the slotted-hole screen can be cleaned without having to empty the mill.

HANDLING

The high degree of flexibility is a result of being able to fit mill housing and agitator shafts of different length to give different milling chamber volumes. This makes milling bin sizes of 250 ml and 1000 ml possible. Clamp closures guarantee simple cleaning and dismantling.

WEAR PROTECTION

The wear parts of the machine are exchangeable and can be made of polyurethane, stainless steel, ceramic, tungsten carbide or plastics.

132 AHM



APPLICATIONS

- Engineering ceramics
- Mineral substances
- Pigments, paints
- Fine-grade chemicals
- Pharmaceutical products
- Dental ceramics
- Food supplements
- Abrasives
- Submicron and nano-scale milling



The Picoliq, the smallest agitated ball mill available, was designed especially for research laboratories and development departments.

picoliq	
Milling chamber volumes	8 - 90 ml
Max. rotor speed	11.000 rpm
Milling bead size	0.1 - 1 mm
Drive power	0.63 kW
Minimum batch size approx.	0.5 g
Throughput rate	0.2 - 30 l/h



90 AHM MOBILE WORKSTATION  
UPON REQUEST ALSO AVAILABLE FOR ATEX ZONE 2

MILLING BEADS



The success of a milling process depends not only on the mill design but a major contribution is made by the type of milling media.

There are milling beads (material, size, etc.) to suit every milling process, and we work in close cooperation with our customers to ensure selection of the ideal media for their application. Milling beads made of all kinds of materials in sizes ranging between 0.1 and 2.5 mm are used in the AHM horizontal agitated ball mill. Rotating pins ensure that the batch of milling media remains loose and separate around the screen.



FEATURES

- High material density increases the energy introduced into the milling process
- Minimal wear and high degree of roundness
- Excellent price-performance ratio
- All standard sizes available ex-Augsburg warehouse

ALPINE POWER BEADS YSZ	
Sizes:	0.1 mm
	0.2 mm
	0.3 mm
	0.4 – 0.6 mm
	0.8 – 1.0 mm
	1.4 – 1.7 mm
	2.0 – 2.5 mm

ALPINE POWER BEADS YSZ  
ZIRCONIA, PARTLY STABILIZED WITH YTTRIUM OXIDE

For standard applications we recommend Alpine's YSZ Power Beads. These milling beads are of exceptionally high quality and the use of first-class raw materials in combination with modern and cost-effective manufacturing processes results in an outstanding price-performance ratio.

YSZ Power Beads are made of a high-grade zirconia raw material in the nanometre range. This material guarantees excellent mechanical properties, high wear resistance and good corrosion resistance. These milling beads are used to achieve maximum milling results at minimum product contamination rates. YSZ Power Beads were designed especially for operation in AHM agitated ball mills.



Chemical composition	ZrO <sub>2</sub> :	94.6 ± -0.2%
ALPINE POWER BEADS YSZ	Y <sub>2</sub> O <sub>3</sub> :	5.2 ± 0.2%
	Remainder:	0.2 ± 0.05%
Specific weight		≥ 6.0 g/cm <sup>3</sup>
Bulk density		≥ 3.8 g/cm <sup>3</sup>
Mohs' hardness		9.0
Breaking load		≥ 1500 N
Roundness		≥ 95 %
Open porosity		0%
Colour		white
Surface finish		white



## NANO-SCALE WET MILLING



Nano-scale milling operations with the AHM are not just restricted to laboratory applications; larger production-scale machines also fulfil the requirements.

### MILLING NANO-SCALE PARTICLES

Nanoparticles are usually produced bottom-up with synthetic processes. But the top-down process by means of mechanical milling or dispersion is also ideal if, for example, synthesis is not possible or is too expensive. With AHM agitated ball mills, fineness values of approx. 10 nanometres can be achieved by means of wet milling under the application of small milling beads. The milling process is carried out in a closed circuit and can take place in water or another suitable liquid.

### DEMANDS MADE ON THE MILL

Particle milling in the submicron range calls for high specific milling energy values and long milling passes. If ultrahigh fineness values are to be obtained efficiently, milling beads in the 0.1-0.5-mm range must be used. The AHM has an effective screening system to keep the milling beads from

compacting together. The mechanical seal and the sealing liquid unit are also equipped for operation with the smallest milling beads. Just as important are efficient wear-protection elements (e.g. YTZ or PU), which reduce contamination of the products to acceptable values in spite of the high milling energy.

### APPLICATION AREAS

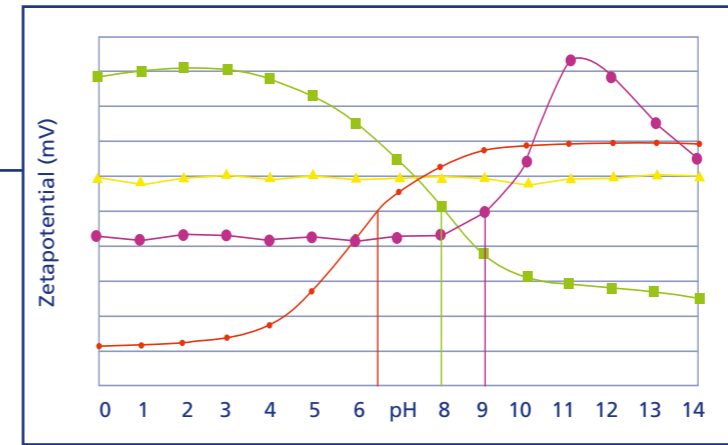
- Pigments
- Fillers
- Carbon
- Aluminium oxide
- Silicates
- Zirconia
- Pharmaceutical active substances
- Dispersion of synthetic nanoparticles



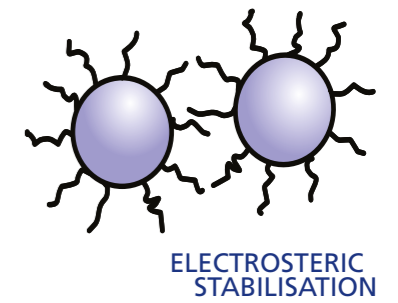
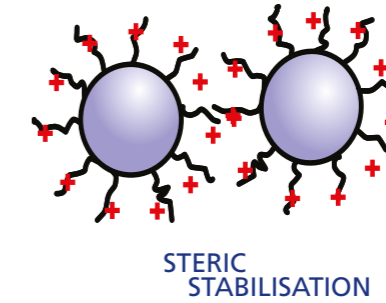
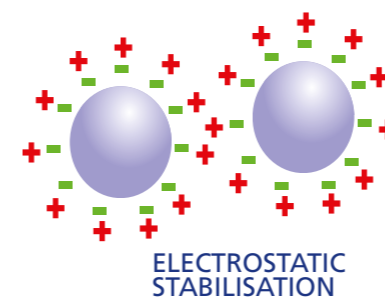
FROM PRODUCTION SCALE TO LABORATORY SCALE

800 AHM  
MILLING CHAMBER: 1056 l  
MOTOR: 316 kW

PICOLIQ  
MILLING CHAMBER: 8 - 90 ml  
MOTOR: 0.63 kW

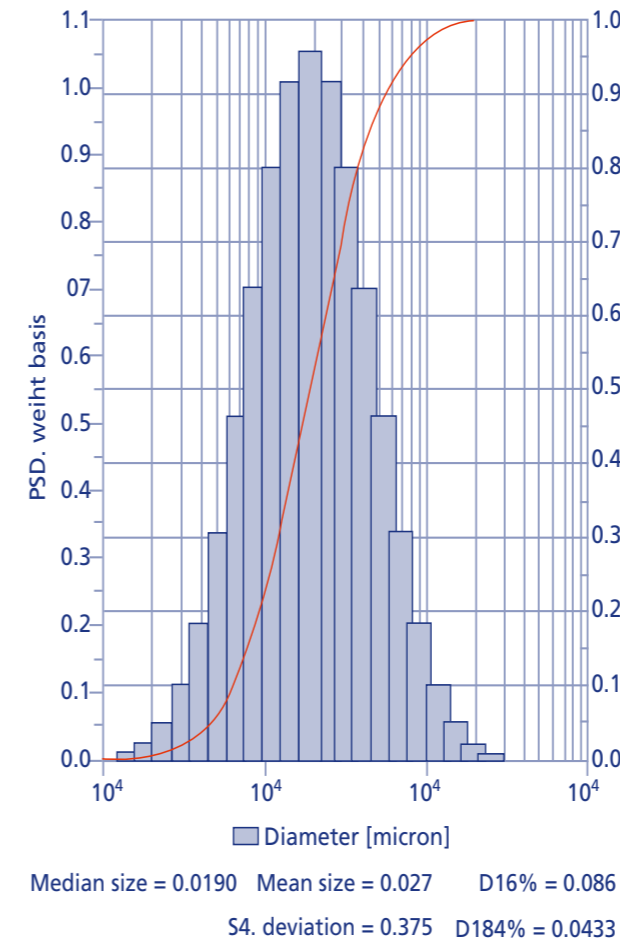


PH-VALUE DEPENDENCY OF THE ZETA POTENTIAL IN THE CASE OF DIFFERENT SUSPENSIONS

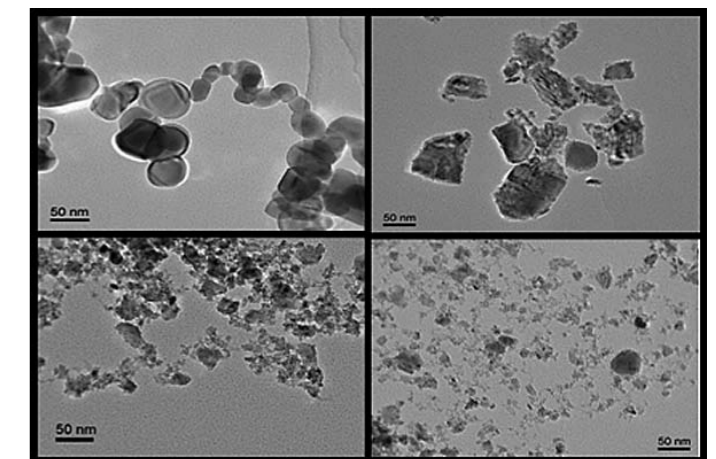


### PARTICLE STABILISATION

The interacting forces between particles in the submicron fineness range lead to strong agglomeration effects which can make nano milling impossible. For this reason, surface-active additives must be used during milling in almost every single case. The stabilisation of individual particles can, for example, be effected electrostatically by changing the zeta potential via the pH value, or sterically by adding long-chain molecules to the particle surface.



### FEED MATERIAL



930 rpm

1500 rpm

Inorganic pigment  
Milling with 200 AHM  
 $d_{50}$  = 20 nanometres  
Throughput approx. 1 kg/h  
Electrostatically stabilised

## EXAMPLE: ENGINEERING CERAMICS



*Optimum wear protection and suitable milling beads ensure that these mills have a long service life even when wet milling hard materials.*

### WET MILLING OF HARD MATERIALS

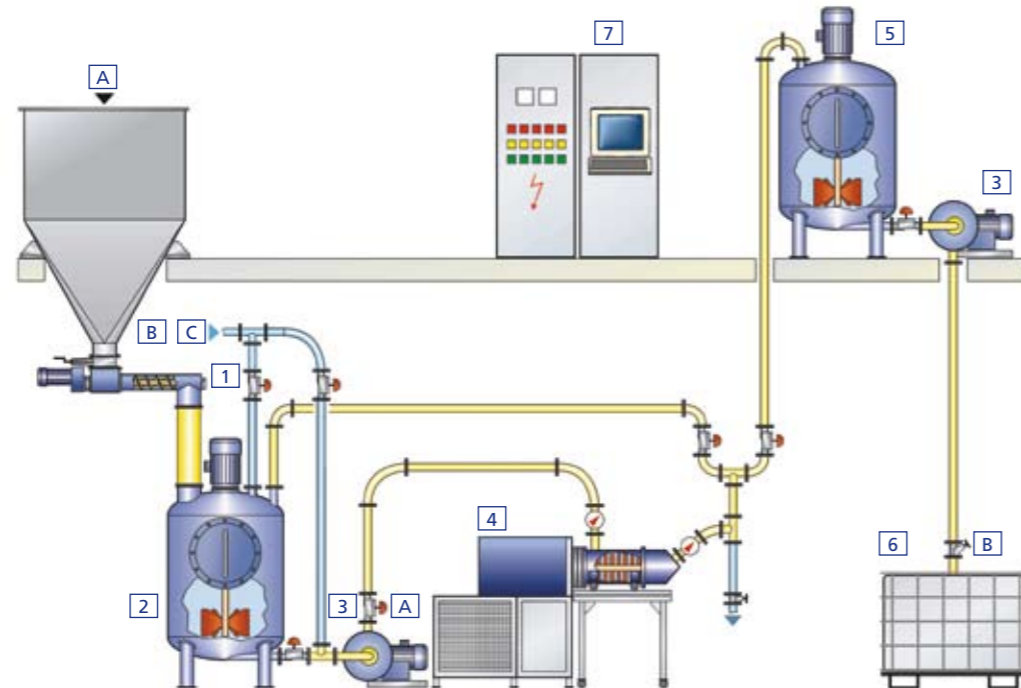
The two illustrated AHM agitator ball mills are generally operated independent of each other in closed-circuit mode. The selected configuration, however, is so flexible that these mills can also be series-connected. This brings advantages if different products are being processed and also offers redundancy with respect to the availability of the milling system.

The suspension is mixed in a bin before being pumped by a hose pump through the mill and back into the bin again. Seen over the running time of the entire milling operation, this results in a specific number of theoretical passes through the mill that influence the milling process.

We also offer different options as regards the system control. Dependent on customer requirements, a PLC unit with different control circuits can be installed to monitor the entire system. Our control systems can be designed for incorporation into existing systems, enabling monitoring of the process from the central control station.



SYSTEM FOR WET MILLING ZIRCONIA



- 1 Feed metering unit
- 2 Mixing and supply tank
- 3 Pump
- 4 AHM mill
- 5 End-product tank
- 6 End-product handling
- 7 Process control
- A Solids
- B Water and additives
- C Cleaning

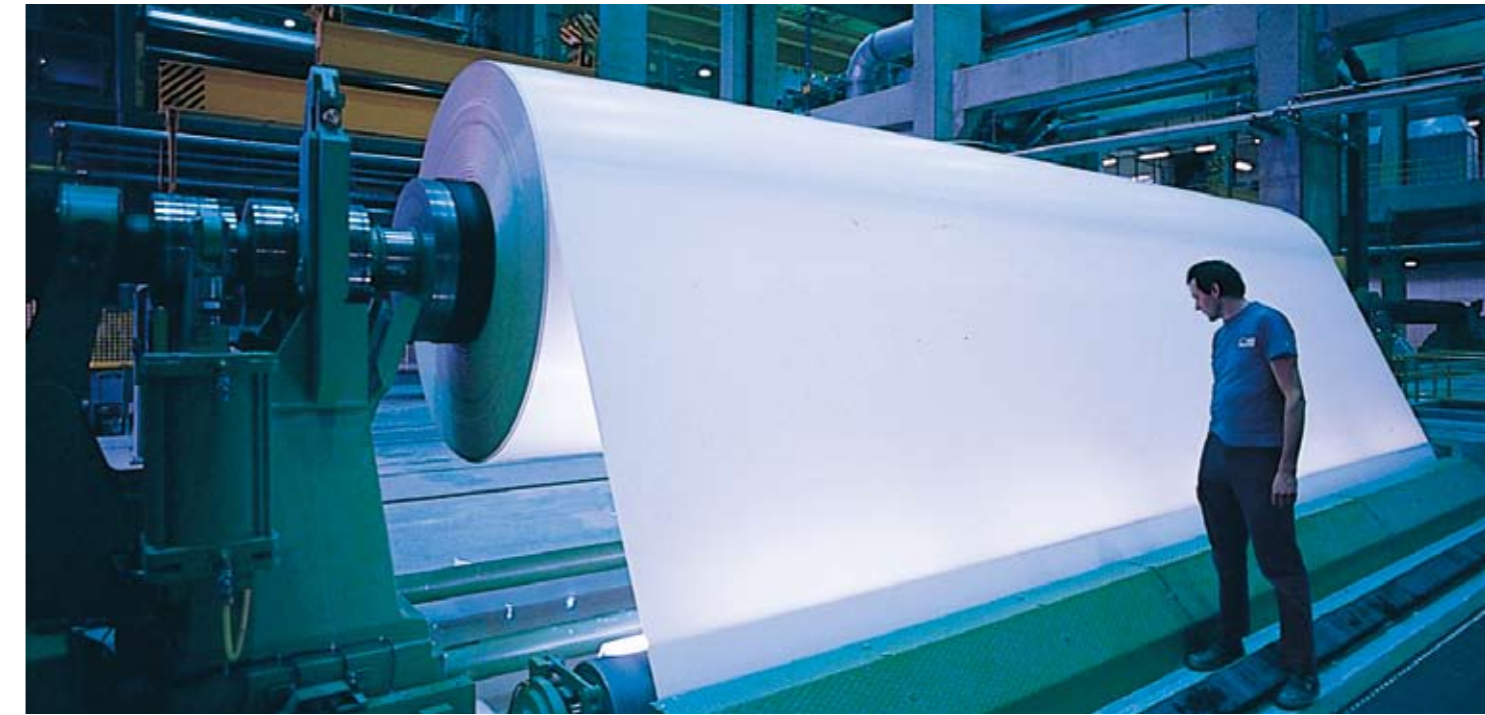
## EXAMPLE: GYPSUM AND KAOLIN FOR THE PAPER INDUSTRY



### TYPICAL TASK

When milling gypsum, additional know-how with respect to the additives used is necessary if the desired specifications are to be met. For coating operations, ground gypsum instead of kaolin can be used. Thanks to the low density, a thicker coating at constant weight (g/m<sup>2</sup>) is achieved with gypsum, or at the same layer thickness, the weight of the paper can be reduced and the gloss increased.

For the paper industry, kaolin and gypsum are ground with the Alpine agitated ball mill AHM. The table below shows typical specifications for kaolin.



Kaolin	Without additives	With additives
End-product fineness	80% < 2 μm	80% < 2 μm
End-product viscosity	< 500 mPas	200 mPas
Solids content	55%	70%



*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 of differing material quality by qualified machinists and welders.
- CNC processing of complex components for film blowing systems and pharma machines using turning, drilling, milling and grinding.

### ASSEMBLY

- Assembly of complicated subassemblies and machines of different design and dimensions.
- 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 in 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.

### 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.

**HOSOKAWA ALPINE** ENGINEERED, MANUFACTURED & ASSEMBLED in GERMANY




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.

