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POWDER AND PARTICLE PROCESSING
ALPINE CLASSIFYING TECHNOLOGY

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.

HOSOKAWA ALPINE

PROCESS TECHNOLOGIES FOR TOMORROW℠

Sichtertechnologie 01.10/1.5 (EN)

HOSOKAWA ALPINE

ONE COMPANY - TWO BUSINESS DIVISIONS

Hosokawa Alpine has been in business for over 100 years. Regardless of the field, i.e. blown film processing or powder & particle processing, we are traditional trendsetters on the market. The driving force behind refining our technologies is the experience we gain and the challenges we face as market leaders.

WE ARE YOUR COMPETENT PARTNER

POWDER & PARTICLE PROCESSING

Formed in 1898, Hosokawa Alpine's range includes the development, design and manufacture of components and turnkey systems to produce powders, granules and bulk materials for the chemical, pharmaceutical, food, minerals, metals and recycling industries. Whether the task is comminution, classification, dust removal, handling, metering, weighing or packing, you will always find Hosokawa Alpine to be a competent and innovative partner.

DIVISIONAL STRUCTURE

The name ALPINE stands for competence in all areas of comminution technology. The long years of close cooperation between our engineers and the development departments of our customers have made us leading specialists for powder and particle processing technology around the world. Because our aim is to offer our customers the very best in professional and accomplished advice tailored to their specific branch of industry, our powder and particle processing division is divided into five subdivisions:

- PHARMA & FOOD

The manufacture of powdery substances for the pharmaceutical industry is a job for specialists. Hosokawa Alpine conforms with international pharma standards and supplies a wide range of products and performance, including special processes for the food industry. Whatever method of size reduction is used, we are the specialists.

- CHEMICALS

The range of chemical products is just as wide and diverse as are the different demands on the properties of pigments or powders. We supply process-technological solutions for the chemical industry as a single-source partner. Our comprehensive range of products means that we are able to meet a vast number of different requirements. We also offer competent advice on solutions for basic chemical products and auxiliary products, as well as for toners, paints, pigments, herbicides or fertilisers.

- Minerals & Metals

We supply complete dry and wet processes with state-of-the-art mills and classifiers for processing mineral raw materials. Our machines and systems for fillers, ceramic raw materials, metallic compounds and alloys all meet the high demands set by our customers. We are not just manufacturers, however, but also competent partners for the engineering and design of complete turnkey systems.

- RECYCLING & GRANULATORS

We design, build and deliver complete granulator systems to include all necessary system components. Whether the feed material is injection mouldings, sprues, film webs or film edge trims, our granulators are designed for even the most difficult cutting tasks. In addition, we also supply in-line recycling solutions for rubber or cable which are tailored to the individual requirements.

- Service

Our service division gives support during the entire lifetime of any Hosokawa Alpine system or machine. Our extensive range of services includes spare parts supply, maintenance, inspection, servicing, repairs, general overhauls, system upgrading, and training. A fairly recent addition to our portfolio of services is a range of pre-owned ALPINE machines.

No matter what part of the world you are in or what your processing challenge is, Hosokawa Alpine is never far away with the best solutions and support. Our range of services includes project management, installation, commissioning, training, maintenance and system upgrades.

BLOWN FILM PROCESSING

As a specialist for film blowing lines to manufacture thin plastic film, Hosokawa Alpine ranks among the world's foremost suppliers in this market segment.
The vast fund of know-how, the high quality standards, the continuous innovation and high degree of reliability are all reasons for the constant growth of this business division.

EVERYTHING FROM ONE SINGLE RESPONSIBLE SOURCE.

ALPINE CLASSIFIER TECHNOLOGY

OVERVIEW

Since the market introduction of the Mikroplex spiral air classifier MP in 1948, Alpine has continued with its successful development and manufacture of air classifiers.

THE CLASSIFIER EXPERTS

We offer systems for a wide variety of different products and fineness ranges, tailored to meet with the technical and economical demands of the individual application.

MULTI-PLEX ZIGZAG CLASSIFIERS MZM AND MZF

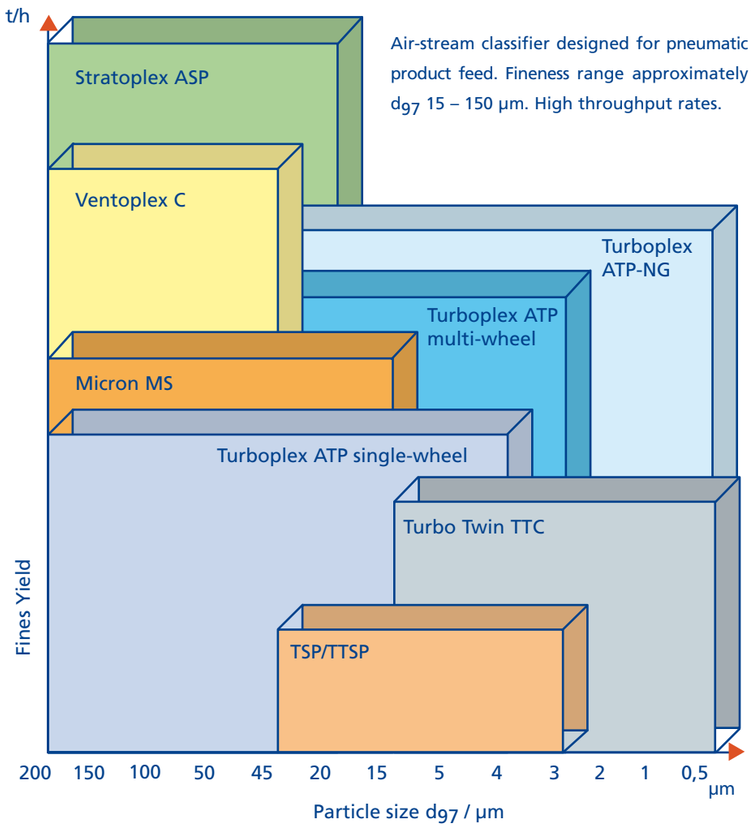
Gravity classifiers for sharp separations in the range 0.3 - 10 mm.

VENTOPLEX AIR CLASSIFIER V

Circuit-air classifiers for high throughputs. Fineness range approx. d_{97} = 32 µm to 200 µm. Low energy consumption.

MICRON AIR CLASSIFIER MS

Air-stream classifier designed for pneumatic product feed. Fineness range approximately d_{97} 15 – 150 µm. High throughput rates.



STRATOPLEX AIR CLASSIFIER ASP

Classifier designed for high throughput rates in the fine to medium separation range of d_{97} 20 – 200 µm. High fines yield with low specific power consumption.

TURBOPLEX ULTRAFINE CLASSIFIERS ATP AND ATP-NG

Single- and multi-wheel classifiers for ultrafine separations. Superfine powders in the fineness range of d_{97} 3 – 10 µm, and in NG design, finenesses down to d_{97} 2 µm (d_{50} 0.5 µm) are possible. Spatter-grain free operation over the entire separation range. Integrated coarse material classifier increases the yield.

TURBO-TWIN-CLASSIFIER TTC

Newly developed classifier wheel geometry pushing the limits of air classification to new levels - d_{50} 0.5 µm achievable.

CLASSIFIERS TSP / TTSP

One- or two-stage ultrafine classifier with a high precision of cut. Ideally suited for classifying toner and pigments, e.g. to minimise the ultrafine portion < 2 - 5 µm (see separate brochure).

GRINDING AND CLASSIFICATION

Where size reduction is required with control of particle size Alpine mills are operated either in conjunction with downstream classifiers or with an integral air classifier.

ZIRKOPLEX CLASSIFIER MILL ZPS

Highly flexible air classifier mill for the processing of soft to medium hard materials. High-speed impact mill combined with single or multi-wheel Turboplex classifier for precise control of product topsize. Fineness range d_{97} < 10 - 200 µm.

JET MILL AFG

FLUIDISED BED OPPOSED JET MILL AFG

For the processing of powders with a Mohs Hardness of up to 10, producing a steep particle size distribution with precise control of product topsize in the fineness range < 5 µm to 200 µm. Classifier wheel(s) incorporated into top section which is hinged back or removed for easy clean.

ZIRKOPLEX ZPS

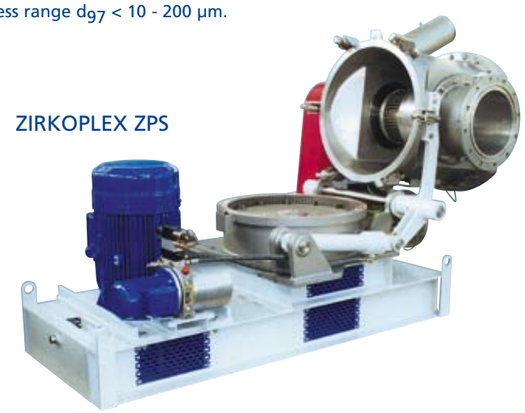


TABLE ROLLER MILL AWM WITH INTEGRATED CLASSIFIER TOP SECTION

ALPINE SUPER ORION SO BALL MILL OPERATED IN CIRCUIT WITH AN ALPINE TURBOPLEX CLASSIFIER ATP

to produce a range of paper filler in coating quality (d_{80} 2 µm) as well as coarse fillers (e.g. dolomite powder for road-work paint with a d_{97} of 100 µm).

BALL-MILL SUPER-ORION

For end-product finenesses of approx. 10 µm - 100 µm. An MS classifier or Turboplex ultrafine classifier is integrated into the mill top section. The grinding process in the material bed is advantageous above all for flaky fillers such as talc or abrasive products such as feldspar.

ALPINE CLASSIFIER TECHNOLOGY

MULTI-PLEX® CLASSIFIER MZM AND MZF

Alpine offers zigzag classifiers in two different designs: MZM and MZF. Each design is available in a range of machine sizes from a single-tube to a multi-tube classifier.

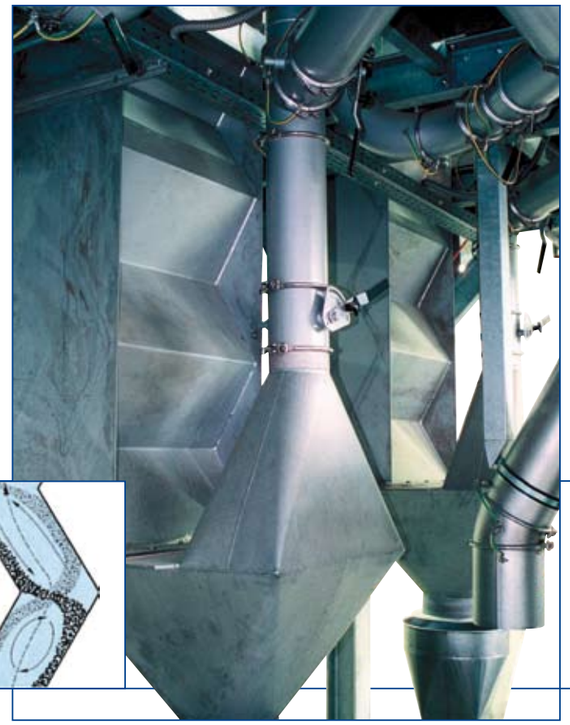
Ideal for sharp separations in the range d_{97} = approx. 0.3 - 10 mm. Throughputs can range from a few kg/h in the case of the laboratory classifier up to approx. 200 t/h for the industrial-scale multi-tube classifier.

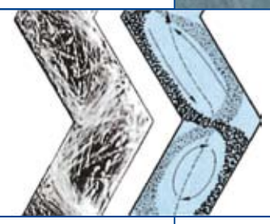
Classification takes place at every change in direction of the Zig-Zag tube and permits an extremely high, steplessly adjustable precision of cut. The result is clean-cut fines or lightweight material, even under overload conditions.

FEATURES

- Maintenance-free and wear-resistant
- Overload-proof
- Insensitive to changes in the feed material composition

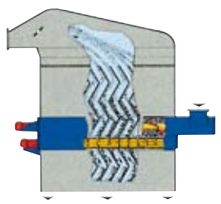
Because of these characteristics once set, the classifying system can be operated over long periods without any supervision at all.





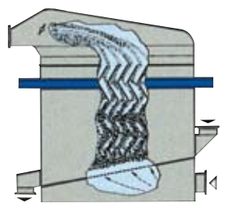
MZM DESIGN

Feature:
Feed material introduced into the middle part of the zigzag tube.



MZF DESIGN

Feature:
Feed material introduced at the lower end of the classifying tube via a flybed channel. MZF classifiers are used for granular materials that are either free-flowing or can be dispersed with air.



APPLICATIONS AREA

OLEAGINOUS FRUITS

Classifying systems for separating cracked soy beans or sunflower seeds.

PRECIOUS METALS

The separation of copper, aluminium or lead from the insulation material of previously cut cable scrap.

Dust removal from plastic granules, coke, chalk, fertilizers, bauxite, etc.

VENTOPLEX® CLASSIFIER C

Internal recirculation air classifier with high fines yield.
Fineness range approx. d_{97} = 32 µm – 200 µm.

FUNCTION

The Ventoplex C is an internal recirculation air classifier. In contrast to the former Ventoplex B with central drive, the new C design has a separately driven classifying wheel. In the new machine, the fan and classifying wheel are coaxially arranged and are driven by means of two separate hollow shafts. This makes it possible for the user to set different speeds and thus permits a significant extension of the fineness range from currently 32 µm to 200 µm.

The product is fed to the centre of the classifier head via a hollow shaft, from which the material falls onto a centrifugal plate underneath the classifying wheel. The centrifugal plate distributes the feed material uniformly in the classifying chamber. Coarse particles fall against the upward flow of classifying air to the bottom, collect in the coarse material cone and are discharged through the side of the machine via a gravity chute. Fine particles in the feed material become entrained in the upward flow of classifying air and enter the classifying wheel along with the classifying air.

The particles in the classifying wheel are classified by the two competing forces, namely centrifugal force and flow force. Coarse particles are rejected by the centrifugal force, whereas for the fine particles, the drag force of the air flow predominates, allowing the particles to pass through the classifying wheel. The Ventoplex air classifier requires no additional external dust collector to separate the fines.

APPLICATION AREAS

Limestone, quick lime, fertilising lime, feed lime, bentonite, dolomite, gypsum, chamotte, quartz, feldspar, pegmatite, raw kaolin, ore, phosphor, glass powder, abrasives, rice flour, bone meal, etc. Because of the high wear resistance and the high achievable fines throughput, the Ventoplex air classifier is ideal for use in the mineral powder industry, especially for ceramic powders that need to be produced without iron contamination.

FEATURES

- Wide fineness range
- High fines throughput rate
- Insensitive to overload
- Low specific energy consumption
- Low peripheral speed
- Low air circulation rate
- Low overall height
- Good accessibility for inspections
- Maintenance-friendly design, use of inexpensive wear parts and thus low maintenance costs.

Ventoplex Typ C		**C9V**	**C12V**	**C15V**	**C18V**	**C21V**	**C25V**	**C28V**	**C32V**	**C36V**
Scale-up factor	F = approx.	1	1.8	2.8	4	5.6	8	10	12.5	16
Drive power of internal fan	kW	3.0	5.5	7.5	11	15	22	30	37	55 - 75
Material feed:		from above centrally via hollow shaft					from the side via feed screw or air conveying channel			
Drive power of classifier	kW	1.5	2.2	3.0	4.0	5.5	7.5	11	15	22
Max. classifier speed	rpm	1120	800	670	560	475	400	355	315	280
Max. feed rate	t/h	3	5	8	12	17	24	30	38	48
Fineness	d_{97} = approx. µm	32 - 200	32 - 200	32 - 200	32 - 200	32 - 200	40 - 200	40 - 200	45 - 250	50 - 250
Fines yield *) d_{97}										
32 µm	t/h	0.4	0.7	1.1	1.6	2.2	---	---	---	---
45 µm	t/h	0.5	0.9	1.5	2.2	3.0	4.3	5.4	6.8	(8.5)
63 µm	t/h	0.7	1.2	1.9	2.8	3.9	5.6	7.0	8.8	11.2
90 µm	t/h	0.9	1.6	2.5	3.6	5.0	7.2	9.0	11.3	14.4
200 µm	t/h	1.6	2.9	4.5	6.4	9.0	12.8	16	20	25.6

*) Reference material: limestone with density 2700 kg/m³; feed material with 70% < d_{97}

MICRON® AIR CLASSIFIER MS

The Micron air classifier is a robust air-stream classifier for separations in the medium fineness range at high throughput rates.

MICRON AIR CLASSIFIER MS

Robust air-stream classifier (pneumatic product feed) for high throughputs.
Fineness range:
approx. d_{97} = 15 - 150 µm. The slow rotation of the MS wheel in the medium fineness range brings advantages regarding the pressure drop and wear rate. The classifier can also be operated with high air flow rates.

PRINCIPLE OF OPERATION

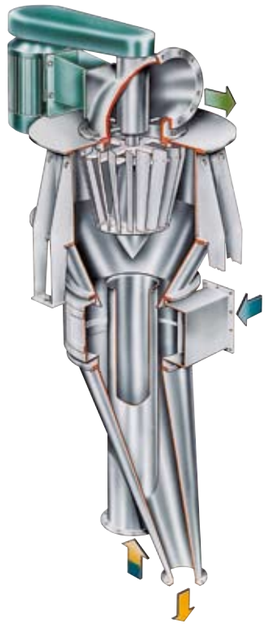
The feed material enters the classifier with the main air flow which can be a highly cost effective process option if integrated into a system with direct pneumatic feed. The classifying wheel is driven by a belt drive and a three-phase asynchronous motor. The classifying wheel speed can be steplessly adjusted by means of a frequency converter. By altering the classifying wheel speed, the particle size can be easily adjusted even during operation. Fine particles whose size is below the set cut point are transported through the rotor blades along with the classifying air, then discharged via the fines discharge in the main air flow, and finally collected in a suitable filter. Coarse particles are rejected by the classifying wheel and discharged via the coarse material discharge. Before being discharged, the coarse material is rinsed intensively in a spiral flow taken from the secondary air stream to remove any last fines, i.e. this final classification step improves the precision of cut and increases the fines yield.

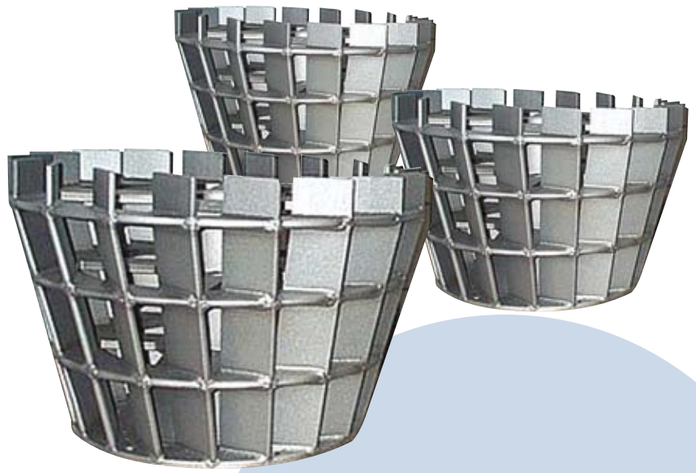
The MS classifier wheel is suspended from a vertical shaft and is of welded construction. The vanes of the wheel are inclined and tapered into a conical shape. During operation oversize product is deflected away from the rotating wheel.

The MS Micron air classifier unit can be operated in closed circuit operation with a ball mill or as a classifier head in conjunction with a table roller mill.

APPLICATION AREAS

Talc, calcium carbonate, bentonite, kaolin, loam, dolomite, quartz, kieselguhr, pigments, fine-grade chemicals, etc.



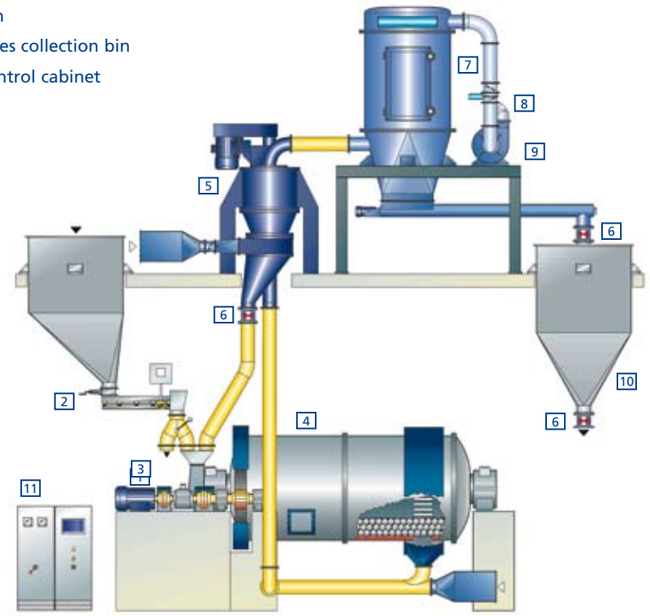


MICRON MS
FOR ABRASIVE MATERIAL

DESIGNS

For operation on abrasive materials the classifier can be offered in a wear protected design. For applications in the food or pharmaceutical industries, the classifier can be manufactured in stainless steel.

1 Feed bin
2 Feed metering unit
3 Change-over flap
4 Super orion ball mill
5 MS air classifier
6 Rotary valve
7 Automatic reverse jet filter
8 Control valve
9 Fan
10 Fines collection bin
11 Control cabinet



Micron Air Classifier Type		MS-1H	MS-2H	MS-3H	MS-4H	MS-5H	MS-6H
Scale-up factor	F = approx.	1	2.7	5	10	20	40
Drive power	kW	5.5	11	15	30	45	55
Max. speed	rpm	5000	3300	2500	1600	1100	800
Air flow rate	m³/h	900 - 1600	2400 - 3600	4800 - 9000	9000 - 18000	18000 - 33000	36000 - 72000
Fineness	d_{97} = approx. µm	7	8.5	10	12.5	15	18
Fines yield, max* d_{97}							
15 µm in t/h		0.16	0.45	0.90	1.50	--	--
20 µm in t/h		0.2	0.6	1.1	2.1	4.2	8.4
45 µm in t/h		0.3	0.8	1.6	2.9	5.9	12.0
63 µm in t/h		0.4	0.9	1.8	3.4	6.7	13.5

* Feed material with 70 % < d_{97}, capacities with minimum airflow rate

ALPINE CLASSIFIER TECHNOLOGY

STRATOPLEX® AIR CLASSIFIER ASP

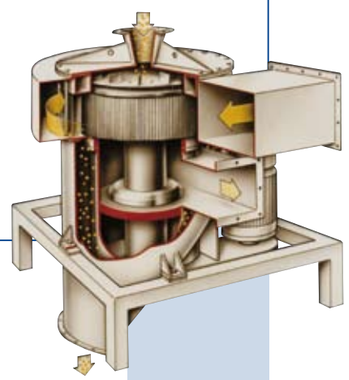
Stratoplex air classifiers are budget-priced standard classifiers for the fine to medium separation range.

Deflector-wheel classifier for the medium-fine separation range between approx. d_{97} = 20 - 200 µm. The Stratoplex is a cost-effective classifier characterised by it's high precision of cut, high fines yield, low energy consumption and ease of adjustment. The cut point can be adjusted by means of a frequency converter as a function of the classifying wheel speed. The two design variants - one equipped for separations in the fine range, the other for separations in the coarse range - make it easy to adjust the classifier for optimum performance on the particular application.

The quality of classification is maintained even when the feed rate is high. And the low pressure drop of only 600 - 800 daPa for the entire classifying system permits extremely low-energy operation.

630 ASP WITH WEAR-PROTECTED CERAMIC CLASSIFYING WHEEL, FINE-RANGE EQUIPMENT

SIMPLE DESIGN



FEATURES

The ASP classifier can be operated in the following modes:
- through-air mode
- circuit-air mode with approx. 10% leakage air

The compact and modular design of the Stratoplex air classifier results not only in maximum performance at modest dimensions, but also permits an easy and space-saving system configuration. And because most of the main components can be accessed easily from above, Stratoplex air classifiers are quick and easy to maintain.

WEAR PROTECTION

In spite of the fact that the wear rate is relatively low, all major product-contact components of the Stratoplex air classifier can be equipped with special wearprotection elements, e.g.
- PUR
- Al_2O_3
- Naxtra

CLASSIFYING WHEEL VANE WITH BONDED CERAMIC OVERLAY

PRINCIPLE OF OPERATION

Because the drive of the Stratoplex air classifier is fitted underneath the classifying zone and the feed product is fed centrally from above, the result is an optimum distribution and dispersion of the product. The feed product is charged by means of the feed unit via the product intake to the centrifugal plate of the classifying wheel, where it is distributed uniformly and radially dispersed towards the baffle ring. The feed material is deflected by the baffle ring and routed downwards into the classifying zone.

The classifying air enters the spiral housing and flows through the helical vanes of the vane ring and the classifying wheel in a centripetal direction. The fines portion is removed thereby from the feed material as it gravitates downwards in the classifying zone, i.e. the zone between the vane ring and the classifying wheel.

The fines, extracted as a function of the cut point set on the classifier, are entrained in the classifying air and flow towards the fines discharge. The fines must be separated from the classifying air in a downstream collection device (cyclone, filter). The coarse material is rejected by the classifying wheel and falls down into the lower section of the classifier.

The coarse material discharge must be air-sealed by means of a rotary valve. Rinsing air, either drawn in automatically or supplied under pressure, prevents unclassified product from migrating into the fines through the gap between the classifying wheel and the labyrinth seal.

The classifying wheel is usually driven via a V-belt drive with a fixed transmission ratio; the classifier speed can be set by means of a frequency converter. The classifier is delivered complete with filter, fan and cyclone.

APPLICATION AREAS

Alpine's ASP classifiers are used above all for processing feldspar, quartz, nepheline, wollastonite, etc.

The Stratoplex ASP is also available in a special design for processing products such as hydrated lime that tend to deposit.

Stratoplex ASP Type	315	400	500	630	800	1000	1250	1500	1800
Scale-up factor F = approx.	1	1.6	2.5	4	6.4	10	16	25	33
Drive power kW	5.5	7.5	11	15	22	37	55	90	132
Speed / coarse rpm	2000	1600	1250	1000	800	630	500	420	350
Speed / fine rpm	4000	3200	2500	2000	1600	1250	1000	840	700
Air flow rate m^3/h	2500	4000	6300	10000	16000	25000	40000	64000	82000
Fineness d_{97} = approx. µm	8	9	10	11	13	15	17	20	25
Fines yield, max*) d_{97}									
20 µm in t/h	1.8	2.1	2.7	3.2	3.8	5.5	6.8	10	-
63 µm in t/h	2.2	3.6	5.4	9	14	22	36	50	80
90 µm in t/h	2.5	4	6	10	16	25	40	55	80

*) Feed material with 70% < d_{97}

TURBOPLEX® AIR CLASSIFIER ATP

The Turboplex classifier is the classic all-rounder, offers the most variations and application possibilities, and is available as a single-wheel or multi-wheel classifier.

HORIZONTAL CLASSIFIER WHEEL

Although the first ATP classifiers (1981) still had vertically arranged classifying wheels, trials showed relatively quickly that a horizontal arrangement is much more advantageous for the Turboplex. There is no need to deflect the fines, meaning that problems with sticky products or hard agglomerates are avoided and that the classifying wheel operates in a product cloud and is thus always uniformly charged.

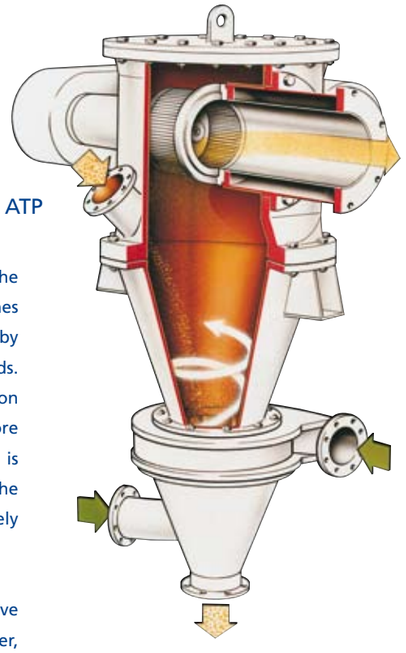
Close manufacturing tolerances make it possible to set a very small rinsing gap which enables particle spatter to be avoided. The maintenance of precise tolerances in the case of the bearings ensures a long service life.

PRINCIPLE OF OPERATION

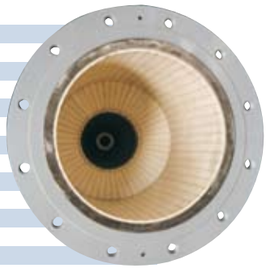
After entering the machine, the classifying air flows through the classifying wheel in a centripetal direction. In the process, the classifying wheel extracts the fines from the feed material and conveys them to the fines discharge. The coarse material rejected by the classifying wheel gravitates downwards. The air routing shown in the schematic on the right is much simplified, because before the coarse material exits the classifier, it is rinsed again intensively by air to remove the remaining fines. This results in an extremely clean coarse fraction.

The product is fed either via a rotary valve or in the case of an air-flow classifier, entrained in the classifying air. Product fineness is controlled by adjustment of the classifier wheel speed using a frequency converter. The horizontal arrangement of the classifying wheel means that even "difficult" products can be processed with no problem.

SINGLE-WHEEL ATP



ENLARGED FINES DISCHARGE



FEATURES

There is hardly another type of classifier that is so well adapted to the demands of practical operation as the Turboplex ultra-fine classifier:

- The simple and robust design reduces costs for maintenance and servicing
- The horizontal arrangement of the classifying wheel reduces wear even with abrasive products and guarantees a long service life
- If processing extremely abrasive products, a wear-protection lining prevents excessive wear
- Modest space requirement
- High fines yield
- Sharp top size limitation.
- Stable operation even if the feed rate fluctuates
- Long service life
- Coating formation prevented, e.g. when classifying $CaCO_3$
- Rinsing gap easy to adjust
- Narrow rinsing gap possible
- Vibration-free

WEAR PROTECION

The applied materials and the wear protection is customised for individual applications. For the pharmaceutical industry the ATP is manufatured in stainless steel.

DESIGNS

For applications on explosive materials, in addition to the standard machine design, with the exception of the 750 ATP and the 1000 ATP all classifiers in the range are available in explosion-pressure-shock-proof design to 10 bar overpressure.

TURBOPLEX ATP SINGLE-WHEEL CLASSIFIER

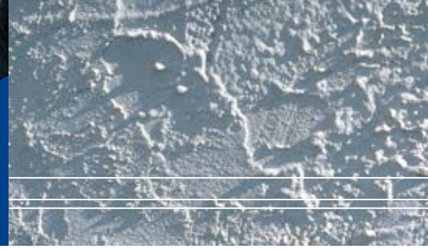
Turboplex ATP	Type	100	140	200	315	400	500	630	750	1000
Scale-up factor	F = approx.	0.25	0.5	1	2.5	4	6.25	10	14	25
Drive power	kW	4	5.5	5.5	11	11	22	30	37	45
Max. Speed	rpm	11000	8500	6000	4000	3150	2400	2000	1600	1200
Max. air flow rate	m^3/h	300	600	1200	3000	4800	7500	12000	17000	30000
Fineness	d_{97} = approx. µm	4-100	5-120	5-120	6-150	7-150	8-150	9-200	10-200	12-200
Fines yield max *) d_{97}										
8 µm in t/h		0.035	0.070	0.14	0.35	0.56	0.80	1.2	-	-
20 µm in t/h		0.07	0.14	0.28	0.70	1.12	1.75	2.8	3.9	6.5
45 µm in t/h		0.1	0.2	0.4	1.0	1.6	2.5	4.0	5.6	9.5

TURBOPLEX ATP MULTI-WHEEL CLASSIFIER

Turboplex ATP	Type	100/4	140/4	200/4	315/3	315/6	500/3	500/4	630/4
Scale-up factor	F = approx.	1	2	4	7.5	15	19	25	40
Drive Power	kW	4 x 3	4 x 4	4 x 5.5	3 x 11	6 x 11	3 x 15	4 x 15	4 x 22
Max. Speed	rpm	11000	8500	6000	4000	4000	2400	2400	2000
Max. air flow rate	m^3/h	1200	3000	4800	9000	18000	22500	30000	48000
Fineness	d_{97} = approx. µm	4-100	5-120	5-120	6-150	6-150	8-150	8-150	9-200
Fines yield max.*) d_{97}									
8 µm in t/h		0.14	0.28	0.56	1.0	2.1	2.4	3.2	4.8
20 µm in t/h		0.28	0.56	1.12	2.1	4.2	5.2	7	11
45 µm in t/h		0.4	0.8	1.6	3	6	7.5	10	16

*) Feed material with 70% < d_{97}

TURBOPLEX®-MULTI-WHEEL CLASSIFIER



Scale-up through the classifier range to achieve greater throughputs influences not only capacity but also the performance of the classifier in terms of the cut point and the precision of cut.

Superfine end products can usually only be manufactured with relatively small classifiers, i.e. laboratory or pilot units, and naturally only in correspondingly small amounts. Once the pilot plant is scaled up to production scale, the desired ultrafine separation is no longer achievable.

Theoretically, during classification of particles separated in the field of centrifugal force, an equilibrium of forces is established between the centrifugal force and the drag force of the fluid flowing around it. According to Stoke's law (Re < 1), which applies in the case of very fine particles examined here, the following is obtained for the diameter of the cut-size:

$$x_T = F \cdot \sqrt{\frac{\eta_L \cdot w_r}{\rho_S \cdot u^2} \cdot D}$$

The cut point size x_T is proportionate to the root of the radial air velocity w_r and the root of the collector diameter D, and inversely proportional to the peripheral velocity u (η_L = dynamic viscosity of the air, ρ_S = density of solid, F = adaptation parameter). For small particle diameters, therefore, it is best to target low flow rates, small classifying wheel dimensions and high peripheral speeds.

The equation also delivers the basis for Alpine's multi-wheel principle: a small wheel can separate finer assuming constant operating conditions.

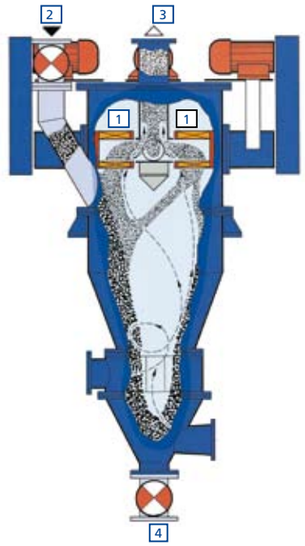
In order to satisfy the demand for superfine products at high throughput rates Alpine developed the concept of the Turboplex multi-wheel classifier whereby several smaller classifier wheels are installed in a single machine. This multi-wheel concept enables the production of superfine products, typically in the 3 - 6 µm range, with an extremely high fines yield at an optimum precision of cut.

The multi-wheel Turboplex classifier operates in conjunction with a single cyclone / filter and fanset so represents a cost effective method of achieving superfine separations at high throughput rates.
Dependent on the end-product fineness, the feed product and the machine size, the feed rate of Turboplex multi-wheel classifiers ranges between about 150 and 30,000 kg/h.

APPLICATION AREAS

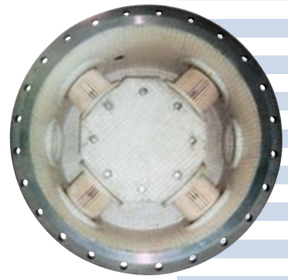
Especially developed for ultrafine classifying operations, Alpine's multi-wheel classifiers are ideal for processing metal powders, mineral powders, abrasives, toner, and wax.

MULTI-WHEEL CLASSIFIER 630/4 ATP



1 Several horizontal classifying wheels of the same diameter are driven independently. The common speed control is accomplished by a frequency converter
2 The product is either gravity fed from the side via a rotary valve or is fed entrained in the flow of classifying air
3 Common fines discharge
4 Coarse material discharge with optimised coarse material classifying

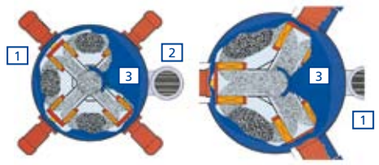
CERAMIC LINING



WEAR PROTECTION

Classifier wheels:
- Al_2O_3 all-ceramic for sizes ATP 50, 100, 200 and 315
- SiC for the sizes 100 and 200
- Steel classifying wheel with tungsten carbide coating

Product-contact classifier parts:
- PUR lining
- Ceramic lining
- Exchangeable steel wear-protection elements with welded special alloy



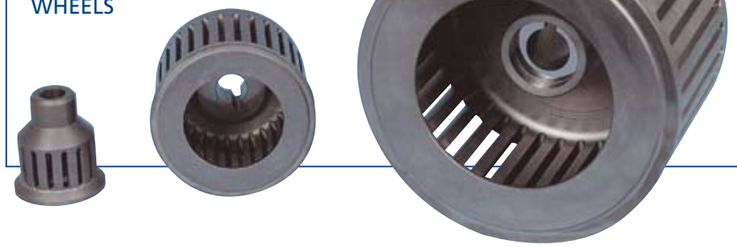
PRINCIPLE OF OPERATION

Besides first-class performance, Turboplex multi-wheel classifiers offer numerous technical and operating advantages:

- Instead of a number of small parallel-connected classifiers, only one single classifier for superfine end products and high throughput rates
- The product is fed via only one single port; this means that only one metering unit is required
- The fines are discharged through a common outlet duct, enabling simple adjust of airflow through the machine
- The coarse material is collected at only one exit point

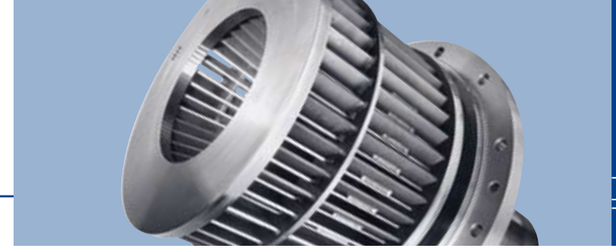
Because of the high throughput rates, Turboplex multi-wheel classifiers can be combined in circuit with correspondingly large mills.

SiC CLASSIFYING WHEELS



ALPINE CLASSIFIER TECHNOLOGY

TURBOPLEX® ATP-NG



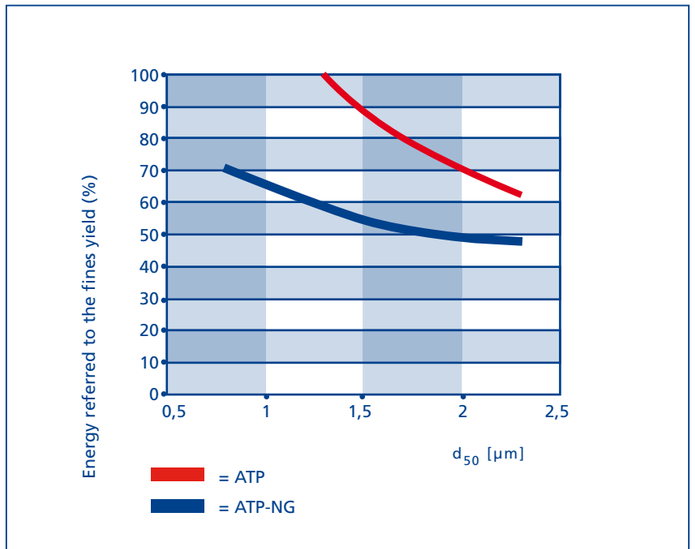
Multi-wheel classifiers are the classifier of choice for ultrafine classifying operations, and because the particle diameter is also directly dependent on the classifying wheel diameter, it is possible in the majority of cases to fulfil customer requirements.

THE TURBOPLEX ATP-NG

In a grinding-classifying circuit, the amount of energy needed for the classification increases with increasing end-product fineness. This fact gave rise to the demand for a low-energy classifier that was capable of achieving fineness values in the range of d_{50} < 1 µm. The "New Generation" Turboplex (ATP-NG) operates in accordance with a completely new classifying principle that is based on the concept of solid-bed flow instead of the conventional potential flow. This new concept has made it possible to reduce the pressure drop and the entire classifying energy quite considerably. A special vane geometry permits a uniform material flow and thus an even finer classification. The advantages of this new classifier generation are especially conspicuous when used in the submicron range: low energy consumption at high yield. Another plus point is the ease with which existing ATP classifiers can be upgraded with the new classifying wheels.

With the new NG wheels, it has been possible to reduce the pressure drop by approx. 60 % when compared with the ATP standard classifying wheel.
And because in the ultrafine range, it has also been possible to improve the yield, the result in many cases is an energy saving of between 30 and 50 % referred to the fines yield. With the new classifier generation, end-fineness values are possible that were to date inconceivable with production-scale systems. And in combination with new mills, e.g. the Hosokawa Alpine ball mill S.O.-SF or the agitated ball mill ATR, fine products with a d_{50} of 0.7 and even 0.3 µm have been achieved.

Whereas when manufacturing ultrafine limestone and talc filler it is the fineness of the classification that is all-important, other applications target a coarse end product with a particle size distribution that is as steep as possible. Here, too, the new generation of classifiers has proved itself.
In contrast to conventional methods, it was possible in this particular case to increase the coarse yield with the new classifier from 33 % to 38 % without any appreciable change to the quality of the coarse material. At the same time, the reduction of the pressure drop also led here to substantial energy savings.



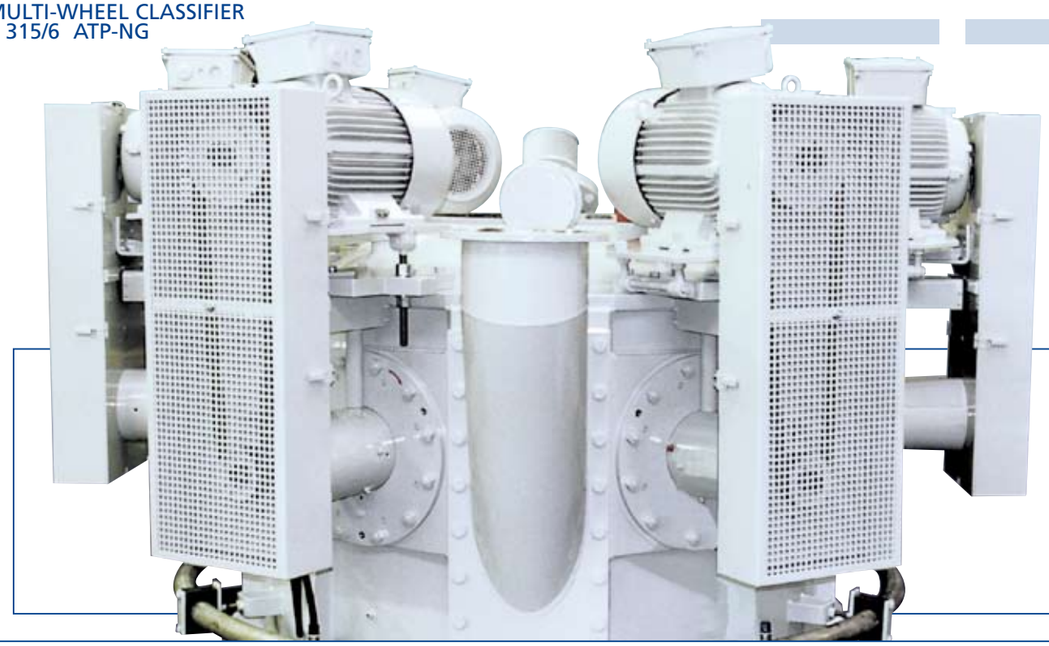
FEATURES

- 30 - 50 % less energy requirement in comparison with the standard Turboplex classifier
- Classification down to d_{50} = 0.5 µm
- High fines yield
- Easy Upgrade - conversion of existing machines to ATP-NG design can be achieved by simple replacement of the classifier wheel and drive unit.

WEAR PROTECTION

- Classifying wheels with tungsten carbide. (Ceramic classifying wheels are not used with the ATP-NG.)

MULTI-WHEEL CLASSIFIER
315/6 ATP-NG



Turboplex ATP-NG Type	315	500	630	750	315/3	315/6	500/3	500/4	630/4
Scale-up factor F = approx.	2.5	6.25	10	13.5	7.5	15	19	25	40
Drive power kW	18.5	30	45	55	3 x 18.5	6 x 18.5	3 x 30	4 x 30	4 x 45
Max. speed rpm	5600	2800	2400	1920	5600	5600	2800	2800	2400
Max. air flow rate m^3/h	3500	8800	14000	22000	10500	20000	26000	35000	56000
Fineness d_{97} = approx. µm	2.5 - 150	3.5 - 150	6 - 200	7 - 200	2.5 - 150	2.5 - 150	3.5 - 150	3.5 - 150	6.0 - 200
Fines yield max*) d_{97}									
4 µm in t/h	0.10	0.25	-	-	0.3	0.6	0.75	1.0	-
5 µm in t/h	0.2	0.45	-	-	0.5	1.1	1.3	1.8	-
6 µm in t/h	0.3	-	-	0.8	-	-	-	-	-
8 µm in t/h	0.4	1.0	1.6	2	1.2	2.3	3.0	4.1	6.2
10 µm in t/h	0.6	1.3	2.0	2.6	1.5	3.1	3.9	5.3	8.5

*) Feed material with 70% < d_{97}

TURBO TWIN CLASSIFIER TTC

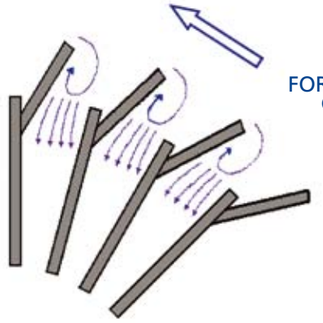
This new classifier for fineness values of d_{97} between 2 and 4 µm at high product yields is ideal for the ultrafine classification of mildly abrasive products such as limestone, talc, silica, graphite, barite, mica and kaolin.

The patented classifying wheel geometry of the Turbo Twin permits high throughput rates and loading factors at a steep top cut, and therefore constitutes an attractive alternative to the Alpine multi-wheel classifiers. The low pressure drop results in an even lower energy consumption than that of the ATP.

The classifying wheel is supported at both ends and permits extremely high speeds, i.e. peripheral speeds of up to 120 m/s can be realised. Product feed is either by gravity or pneumatic.

The classifier bottom section corresponds to that of the ATP, meaning that any existing ATP machine can be retrofitted with the TurboTwin classifier.

The classifying wheel is driven by means of a three-phase asynchronous motor with frequency converter and flat belt drive. There are currently 5 machine sizes with drive outputs between 18.5 and 132 kW available.



FORCED VORTEX FLOW IN CLASSIFYING WHEEL

APPLICATION AREAS

- Superfine end products
- Mildly abrasive feed products, e.g. limestone, talc, silica, graphite, barite, mica, kaolin

WEAR PROTECTION

- Naxtra classifying wheel
- and tungsten carbide coating

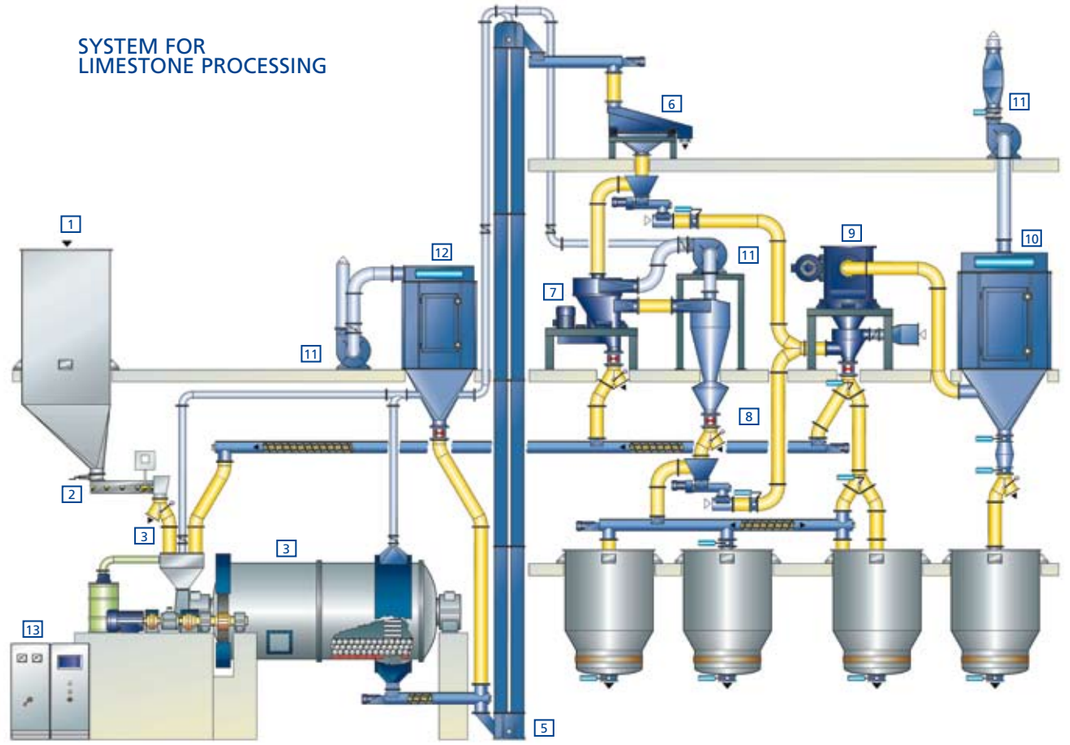
TURBO TWIN CLASSIFIER TTC

1. Feed bin
2. Feed metering device
3. Diverter valve
4. Super Orion Ball Mill S.O.
5. Bucket elevator
6. Safety screen
7. Stratoplex Classifier ASP
8. Cyclone
9. Turbo Twin Classifier TTC
10. Product collection filter
11. Fan
12. Nuisance dust extraction
13. Control cabinet

Turbo Twin Classifier TTC Type	200	315	500	630	710
Scale-up factor F = approx.	1	2.5	6.25	10	12.5
Drive power kW	18.5	30	55	90	132
Max. speed rpm	10000	7300	4600	3650	3250
Max. air flow rate m³/h	1600	4000	10000	18000	25000
Fineness d_{97} = approx. µm	2.5	3	3.3	3.5	4
Fines yield max*) d_{97}					
3 µm in t/h	0.04	0.09	-	-	-
4 µm in t/h	0.07	0.18	0.42	0.63	-
5 µm in t/h	0.11	0.26	0.65	0.98	1.3
6 µm in t/h	0.14	0.35	0.88	1.4	1.9
8 µm in t/h	0.23	0.56	1.4	2.3	2.9
10 µm in t/h	0.28	0.79	1.8	2.8	3.5

*) Feed material with 70% < d_{97}

SYSTEM FOR LIMESTONE PROCESSING



PRODUCTON OF DUSTFREE COARSE WITH THE CLASSIFIER TSP AND TTSP

In contrast to all other ultrafine classifiers featured in this brochure, the TSP is not oriented towards obtaining spatter-grain-free fines but rather towards the achievement of clean coarse fractions. Thanks to the special design of this classifier, the coarse material can no longer be contaminated by fresh material once it has passed through the classifying zone. This results in high-quality coarse material and extremely good yields. In other cases, the separated fines must often be reprocessed, and this naturally involves costs. In other words, the high coarse yields make an effective and lasting contribution towards reducing production costs. The two following graphs document the dust removal efficiency and the respective coarse material yield.

The classifier is employed in all those cases where the requirement is for high-quality dust removal - for example, in the case of pigments, silicic acid, powder coatings, chemical additives and toner.

(See separate brochure “Powder and particle processing for the toner industry”.)

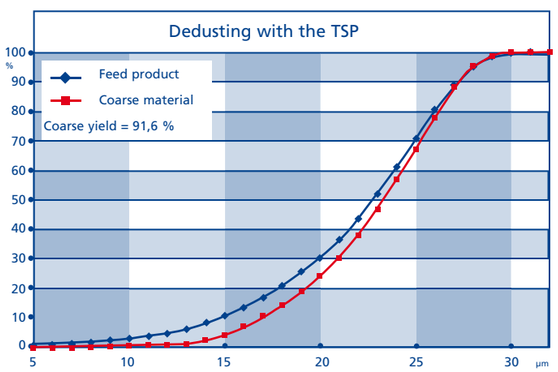
TONER CLASSIFIER 200 TTSP

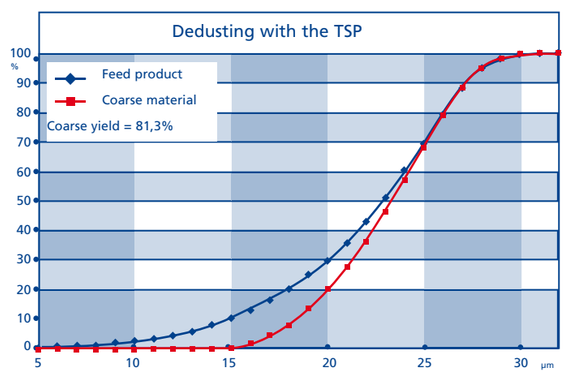
SIZE 100 TTSP READY FOR SHIPMENT

DESIGN VARIANTS TSP

- Pressure-shock-proof design to 10 bar overpressure
- Mild steel
- Stainless steel
- Small classifiers in monobloc design
- To order, product-contact surfaces polished to R_a 0.8 µm
- Wear-protected (hard-metal-coated) classifying wheel.

TSP Classifier	Type	200	250	315	400	500
Scale-up factor	F	1	1.6	2.5	4	6.3
Classifier drive	kW	3	5.5	7.5	11	18.5
Nominal air flow rate	Nm^3/h	560	900	1400	2300	3600
Feed rate	kg/h	60	90	140	230	360





SYSTEM EXAMPLE LIMESTONE FILLER FOR THE PAINT INDUSTRY

The fillers of choice in the paint industry are limestone, and especially marble or calcite.

The advantages of these fillers are their:

- chemical stability, i.e. good weather-resistance
- mechanical strength, i.e. increased scratch-resistance
- alkaline behaviour, i.e. increased corrosion-resistance

For matt and satin-finish paints, a standard filler with a d_{50} to 2.5 µm is used. In the case of this standard filler, the industry demands are extremely high.

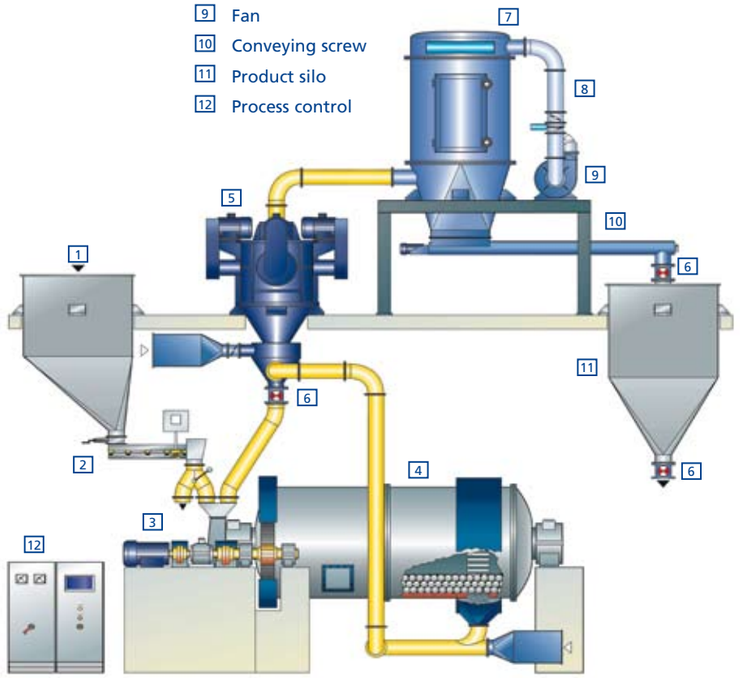
Requirements:

- low price
- sharp top size limitation
- consistent product quality

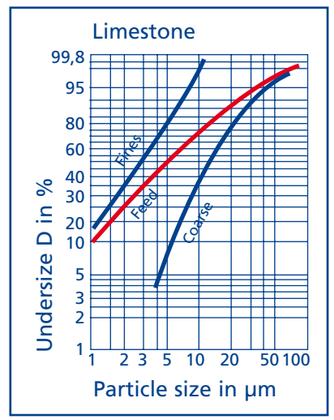
For the production of these fillers, Alpine offers compact systems (flow chart) that include a large ball mill and large multi-wheel classifier. The ground product is conveyed to the ATP classifier direct from the mill entrained in the classifying air. This solution has the following advantages:

- an extremely compact system set-up, in other words low building costs,
- less units, i.e. low maintenance costs and high availability,
- fine end product with sharp top size limitation,
- monitoring of all product parameters, in other words a constantly high product quality and the possibility of automatic, i.e. unmanned, shift operation.

1 Feed bin
2 Feed metering device
3 Diverter flap
4 Super Orion Ball Mill S.O.
5 Turboplex air classifier ATP
6 Rotary valve
7 Product collection filter
8 Air flow control
9 Fan
10 Conveying screw
11 Product silo
12 Process control



Ball Mill S.O.	Classifier ATP	Throughput t/h	Fineness d_{97}
200/600	500/4	3.0	8 µm
270/400	500/4	4.0	8 µm
300/500	630/4	6.0	8.5 µm



SYSTEM EXAMPLE PROTEIN SHIFTING

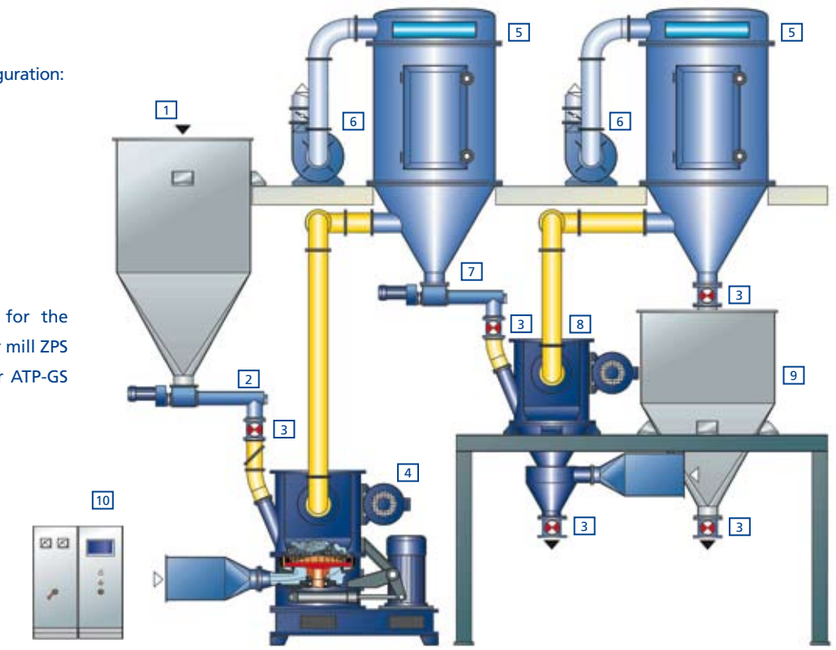
Alpine employs the Turboplex ultrafine classifiers to achieve precise separations into a high-protein fraction and a low-protein fraction.

The classifiers have a high precision of cut, deliver top quality, a high proportionate yield and extremely low-protein flour concentrates. We distinguish here between standard and precision processes.

Precision process: This is used for wheat flour and a multitude of other raw materials.
The process employs the Zirkoplex classifier mill ZPS (4) for the fine grinding and the Turboplex ultrafine classifier for the separation.

Mill ZPS	Classifier ATP-GS	Feed kg/h	Yield %	Protein content % Fg	Gg
315	315	500	20 - 25	approx. 20	5.5 - 6
500	315	1250	20 - 25	approx. 20	5.5 - 6
630	500	1800	20 - 25	approx. 20	5.5 - 6
750	750	3000	20 - 25	approx. 20	5.5 - 6

1 Feed bin
2 Feed metering device
3 Rotary valve
4 Zirkoplex classifier mill ZPS
5 Product collection filter
6 Fan
7 Feed screw
8 Turboplex classifier ATP
9 End-product bin for fines
10 Process control



Soft wheat flour:
Reference values for the system configuration:
- Protein content: approx. 10 %
- Flour fineness:
  approx. 65 % < 32 µm
  approx. 85 % < 63 µm
  Fg = fines
  Gg = coarse material

The table gives reference values for the combination of a Zirkoplex classifier mill ZPS with a Turboplex ultrafine classifier ATP-GS as shown in the system schematic.

APPLICATION TESTING CENTRE

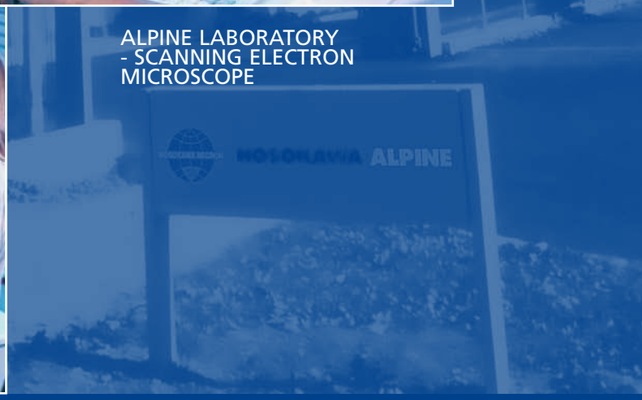
The design of a grinding and classification system is normally based on results from a programme of trials conducted in the HOSOKAWA ALPINE Test Centre. The trials can be complex and time consuming and can include evaluation of a wide range of machine options. This way, customers can be assured that all process options have been considered and that the system offered represents the optimum solution.
Our test centre is extensively equipped with a wide range of different grinding and classification systems, available both on a laboratory and production scale. The test facility is supported by a modern testing laboratory that includes a wide range of analytical equipment enabling accurate measurement of particle size, particle shape, density, etc.

Skilled and vastly experienced Alpine Engineers conduct the trials, recording all operating data that enables ongoing discussions with the customer during the trial. Upon completion of the trial a comprehensive test report is prepared which can then be used for system design and as the basis for a performance guarantee.

It is essential that test facilities are kept at the leading edge of technology if optimum baseline data is to be provided for system design. Our range of machines and systems is continuously upgraded and is extended by new developments.

ALPINE TESTING CENTRE IN AUGSBURG

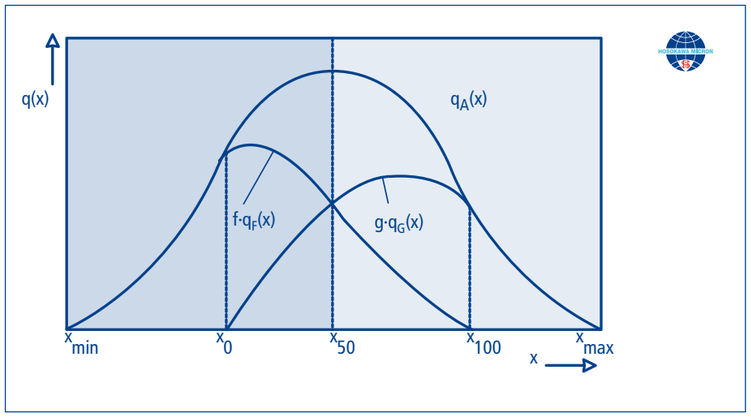
ALPINE LABORATORY - AIR JET SIEVE 200 LS-N



ALPINE LABORATORY - SCANNING ELECTRON MICROSCOPE

Air classification is a method of separating powdery, granular or fibrous materials in accordance with their settling velocity as a function of particle size, density and particle shape. Ideally, the separation effect of an air classifier should be such that all particles which exceed the "cut point" are transported into the coarse fraction and the smaller particles into the fines fraction. Such accuracy, however, is virtually impossible to achieve. Regardless of the type of air classifier used, a certain amount of fines is always going to be present in the coarse fraction and vice versa, the so-called overlap zone.

FREQUENCY DISTRIBUTION CURVE



Symbols
x = Particle size
f = Fines fraction
g = Coarse fraction
g + f = 1

Frequency distribution
q_A (x) = Feed material
q_F (x) = Fines
q_G (x) = Coarse

Cumulative distribution
$Q_A(x)$ = Feed material
Q_F (x) = Fines
Q_G (x) = Coarse
T(x) = Grade efficiency (according to Tromp)

The scientifically precise representation of a separation is the grade efficiency or Tromp curve T(x). The grade efficiency is defined as that portion of feed material which migrates into the coarse fraction. In practice, however, the grade efficiency curve is seldom determined because for most customers, it is usually the fineness and the fines yield that are the crucial criteria.

$$T(x) = \frac{g \times q_G(x)}{q_A(x)}$$

The median x_{50} (T(x) = 0.5) of the grade efficiency curve is called the cut point. Fine separations achieve cut points to the order of 1 µm these days. The steepness of the grade efficiency curve κ is approximated in the equation:

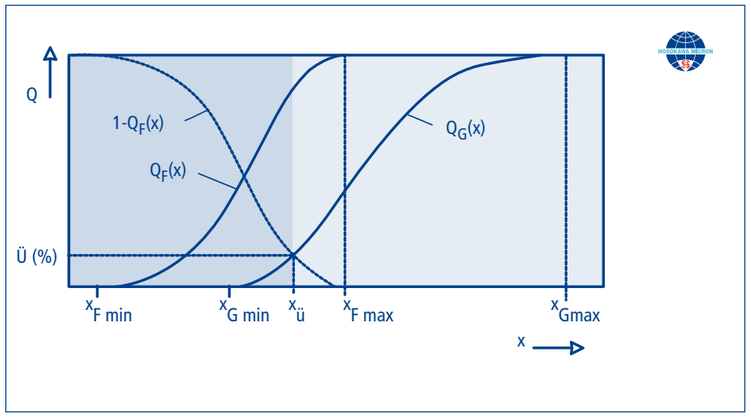
$$\kappa = \frac{x_{25}}{x_{75}}$$

The steepness is a measure for the precision of cut, whereby good values for κ range between 0.5 and 0.6. If the requirements are extremely high regarding the purity of the coarse material, values of around 0.8 can also be achieved. In many production systems, however, the classifiers are so heavily loaded that the grade efficiency curve in the fine range does not go below 0.25. In this case, κ cannot be determined.

Because calculation of the grade efficiency curve is relatively time-consuming, the so-called overlap cut point $x_{Ü}$ is applied in practice. This can be determined very easily in the particle size distribution diagram from the cumulative undersize curves of both fine and coarse material.
The following applies:

$$1 - Q_F(x_{Ü}) = Q_G(x_{Ü}) = Ü$$

OVERLAP CUT POINT $X_{Ü}$



The overlap Ü is now in turn a measure for the precision of cut. Extremely sharp separations can achieve an overlap of only 5%. In many cases, however, the overlap will have a value of 10%; and in the case of heavily loaded mineral powder classifiers and difficult feed materials, the overlap can be between 20 and 25%. The mass balance of a classifier results in:

$$f = \frac{Q_A(x_{Ü}) - Ü}{1 - 2 \times Ü}$$

With this equation, an experienced engineer can estimate the expected fines portion f for different cut points from a known feed particle size distribution $Q_A(x)$. This is much more difficult to determine for classification than it is for screening.

The mass flow rates in large production-scale systems can often only be measured with great difficulty or over long periods of time. The fines portion can be calculated using the particle size distributions of feed material, fines and coarse material as shown in the equation below.

$$f = \frac{Q_A(x_0) - Q_G(x_0)}{Q_F(x_0) - Q_G(x_0)}$$

One needs to consider the feed material, fines and coarse material of the same particle size x_O in order to calculate the fines portion from the cumulative undersize at this particle size.

HOSOKAWA MICRON GROUP

WORLDWIDE

The HOSOKAWA MICRON GROUP is an international supplier of machines, systems, processes and services.
Based on this comprehensive performance range, HOSOKAWA offers process solutions for a great number of different business segments:

PROCESS TECHNOLOGIES FOR TOMORROW℠

1. POWDER AND PARTICLE PROCESSING

HOSOKAWA is the world's largest provider of processing systems for the field of powder and particle processing. Renowned names such as ALPINE, Bepex, Stott, Vitalair, Rietz, Mikro, Micron, and Vrieco-Nauta are all included in the Group's range.
Regardless of the size, i.e. production-scale systems, pilot systems or laboratory equipment, HOSOKAWA's products and technologies are used in numerous process stages, for example during comminution, mixing, drying, agglomeration, classification, weighing and metering.

2. BLOWN FILM PROCESSING

HOSOKAWA ALPINE is one of the world's foremost suppliers of film blowing systems. As a one-stop shopping partner, Alpine supplies complete systems for the manufacture of blown film, from granule feeding systems to film winders, from single-layer die heads to 9-layer lines, and from simple speed regulators to state-of-the-art process control systems. And with ALPINE's own film orientation lines, complete systems are now available which facilitate film upgrading and enhancement processes.

3. CONFECTIONERY & BAKERY TECHNOLOGY

The vast fund of know-how built up by the Bepex, Kreuter and Ter Braak companies over many long years makes the HOSOKAWA Confectionery and Bakery Group the ideal partner for the confectionery industry. A complete range of machines and production systems is available or can be custom-designed for each process step, from preparation of the raw materials and confectionery pastes to the end product.

HOSOKAWA ALPINE

POWDER AND PARTICLE PROCESSING

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