Symbols (inside)



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In view of their policy of continuous improvement, the company reserves the right to change the specification and design.

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Headquarter and two of our aluminium pigment manufacturing sites



Barnsdorf, Germany



Taixing, China

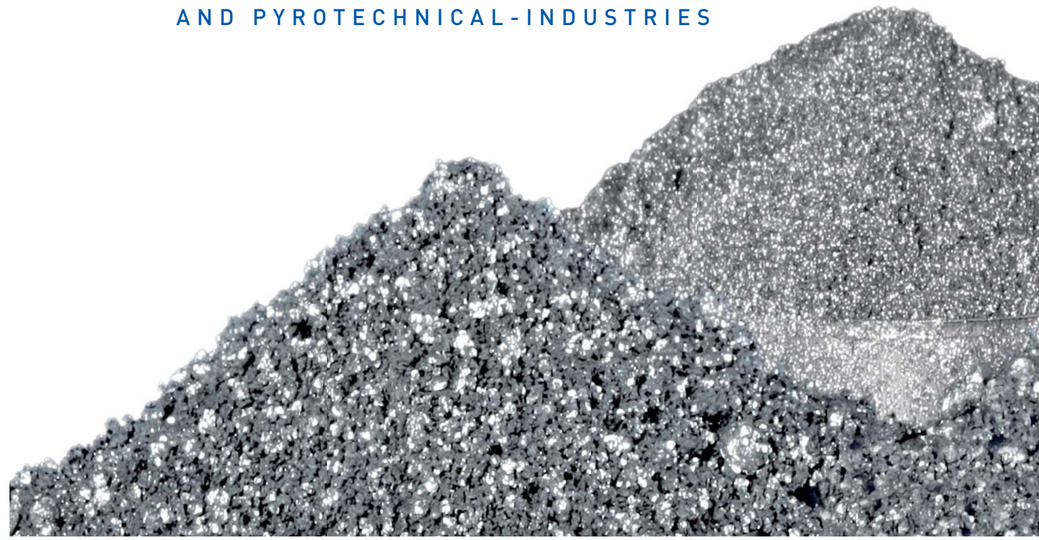
World of Metallics



SCHLENK

Technical Aluminiumflakes

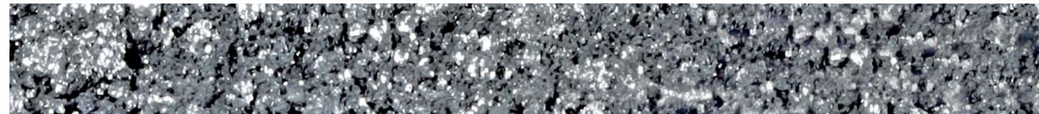
FOR BUILDING MATERIAL-, CHEMICAL- AND PYROTECHNICAL-INDUSTRIES











Symbols



Building Materials



Pyrotechnics



Explosives



Smoke



Illumination



Cracker



Lightning



Chem.-techn. Applications

TECHNICAL ALUMINIUMFLAKES

SCHLENK

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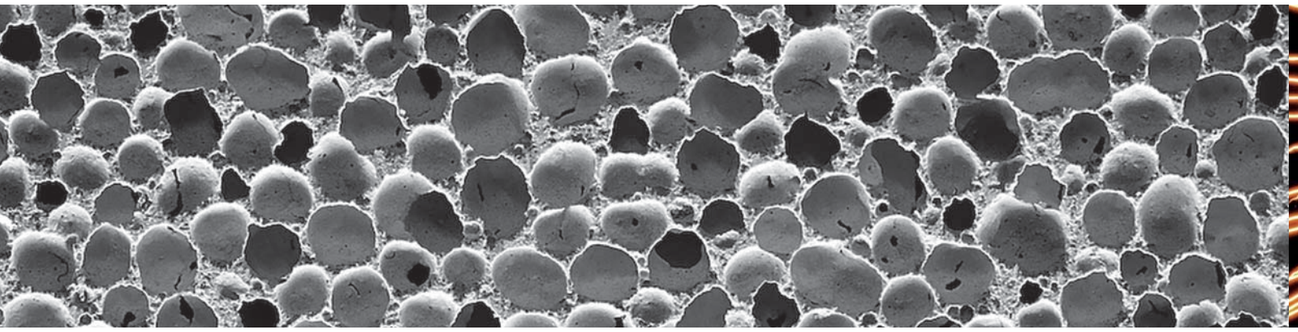
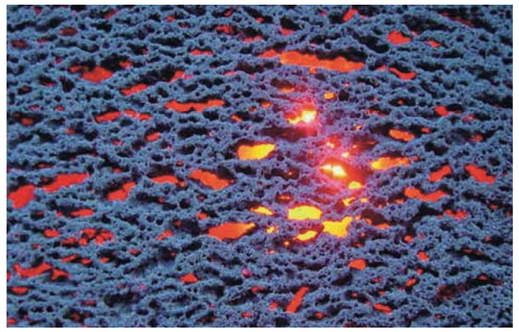







1 General Introduction

Carl Schlenk AG – your partner in progress

Schlenk Metallic Pigments GmbH, part of the Carl Schlenk AG group, is the leading supplier of technical aluminium flakes globally, providing an unrivalled and unique product portfolio.
We offer aluminium flakes in both powder and paste forms, in either organic solvent or water, depending on application requirements. This gives our customers optimum processing performance, with short dispersing time, when using aluminium flake products.

An extensive portfolio – the perfect match to our Customer's needs

Our product range can be split into three areas of application: Aerated Concrete and construction chemical applications for Building Materials, Chemical Industry and Pyrotechnics.
Our aluminium flakes are an essential raw material for production of the light-weight concrete building materials.

For many years Schlenk Metallic Pigments GmbH has been at the forefront of aluminium flake development for use in construction materials. Aluminium flake is used as a foaming agent in the manufacture of lightweight concrete and special plasters and mortars. In the Chemical Industry aluminium flakes are needed for their high energy potential in exothermic reactions. They are also used as a reducing agent to create brilliant white titanium dioxide pigments. Aluminium flakes are also an important ingredient in many pyrotechnic products.

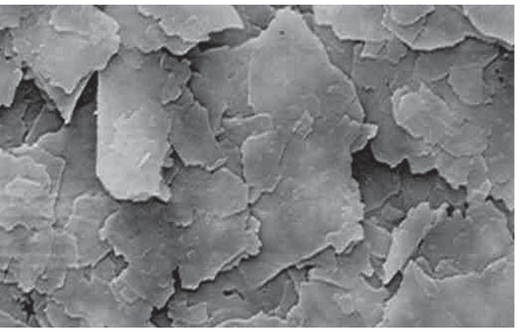
Our services – exemplary in every respect

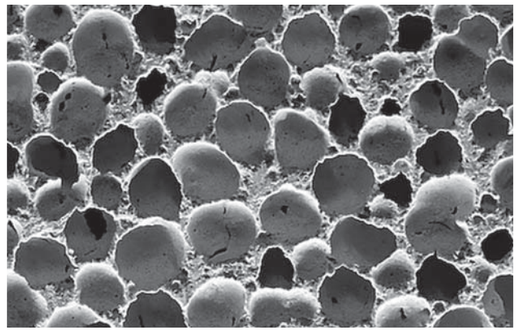
The Carl Schlenk AG unites nine production sites globally and offers a sales network with offices and subsidiaries in more than 70 countries worldwide.
The name Schlenk represents continuity and reliability, innovation and premium quality. This is all backed up with our outstanding personal customer service.
We have customer consultants and sales representatives covering the globe to help our customers in every aspect of supply chain management when purchasing aluminium flake products.

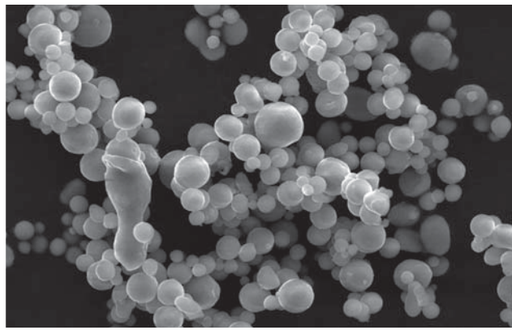
Visible commitment – environmental awareness within Carl Schlenk AG

At Carl Schlenk AG our pioneering role goes beyond product development. We are also dedicated to environmental stewardship in areas that our business affects. We continually review our products and manufacturing processes to minimize eco-impact and maximize sustainability.

Technical Aluminiumflakes







2 Aluminium Flakes for the manufacture of aerated concrete and construction chemical applications for Building Materials

2.1 Introduction

A history of aluminium flake development for concrete

The first tests with aluminium flakes as a foaming agent in cement containing masses were made at the beginning of the 20th century. Alysworth and Dyer discovered in 1914 that adding aluminium pigments to fresh concrete mixture created a chemical reaction that resulted in hydrogen gas bubble formation. This type of concrete, with its technical and economic advantages, has been used widely around the world ever since.
The first industrial production of AAC started in 1929 in Sweden.
Aluminium flakes were traditionally made with stamping machines. With increasing demands on the performance properties of the flakes, modern aluminium flakes are manufactured by using ball mills.
They can also be produced with a variety of surface chemistries for different applications. With the rapid development of aerated concrete blocks, aluminium flakes with improved wetting in water were soon required.

In 1956 Schlenk started production of aluminium flakes for the AAC industry.
New aluminium flakes were developed in the 1960s by Schlenk in cooperation with the leading aerated concrete manufacturers. This resulted in the first industry standard product for the AAC process, aluminium powder 2307. This powder was developed further into powder products 4307 and 8010.

Aerated concrete – three product lines for the most demanding requirements

The energy balance of a building today mainly depends on the thermal insulation properties of its wall construction materials. Continuously increasing demands for the best possible energy efficiency have led to the need for construction materials with the best possible insulation properties. Aerated concrete belongs to the group of light-weight wall construction materials. AAC blocks, manufactured from porous concrete, usually receive their final product characteristics after steam curing in autoclaves.

The autoclaving process gives the material a high strength to weight ratio. This gives aerated concrete products the perfect combination of fundamental construction requirements with top thermal insulation properties.

Today's Market Leader

Today we have the most extensive range of aluminium flakes for the building material application at our command:

- **aluminium powder**
- **water-based aluminium pastes (Aquapor®)**
- **solvent-based aluminium pastes (DEG = diethylene glycol)**

Our product portfolio makes Schlenk the perfect supplier of customized solutions for lime-rich and concrete-rich formulations and for dosages in powder and paste-like form. Optimized manufacturing processes can be achieved at our customers' by using accelerated or retarded reaction products. This allows the desired gross density of the aerated concrete product to be achieved with full control and efficiency.

Construction chemical applications

With our wide range of powders we are able to supply aluminium powders suitable for other construction chemical applications. We offer different blends of dry powder bulk materials and flaky spherical aluminium. This is supplied in an optimum ratio for our customers. Fields of application for such dry batches are:

- **renovation render or insulating plaster**
- **screed cement and concrete for shrinkage compensation or crack avoidance**
- **mixtures for filling cavities**

One main benefit of these mixtures is, they can be shipped and processed without hazardous goods label. In addition to limestone we can also supply a multitude of other inorganic powder bulk materials ready-mixed with our aluminium powders.

2.2 Test Methods

ALUMINIUM POWDERS

Schlenk offers aluminium powders which disperse very well in water. Hence, there are almost no handling restrictions concerning its use in processing. Aluminium powders are typically applied in single-batch dosing systems. Each setting of this mixture is steadily renewed and thus comes in high frequency. Only such readily dispersible powders provide the full benefit of this dosing technology, combining high production flexibility with excellent dosing accuracy, while maximum production capacity is maintained.

The most important properties to characterize our aluminium powders are:

- **Median particle size –** d_{50}-value, measured by LASER granulometry. This is a significant value for the fineness. Together with the d_{10}-value and the d_{90}-value, it defines the entire particle size distribution of the aluminium powder (see figure below).
- **Sieve residue 45µm –** A complementary method to characterize the fineness.
- **Bulk density –** A shape parameter, also to define the container size in the aluminium dosing systems.
- **Wettability in water –** Guarantees quick dispersion and homogeneous distribution of the aluminium flakes in the suspension and in the AAC mixture.
- **Active metal content –** Defines the purity of the metal source.
- **Gas reaction –** Characterizes the reaction kinetics of pore forming processes (see chart below). It has to fundamentally match the client's production processes.

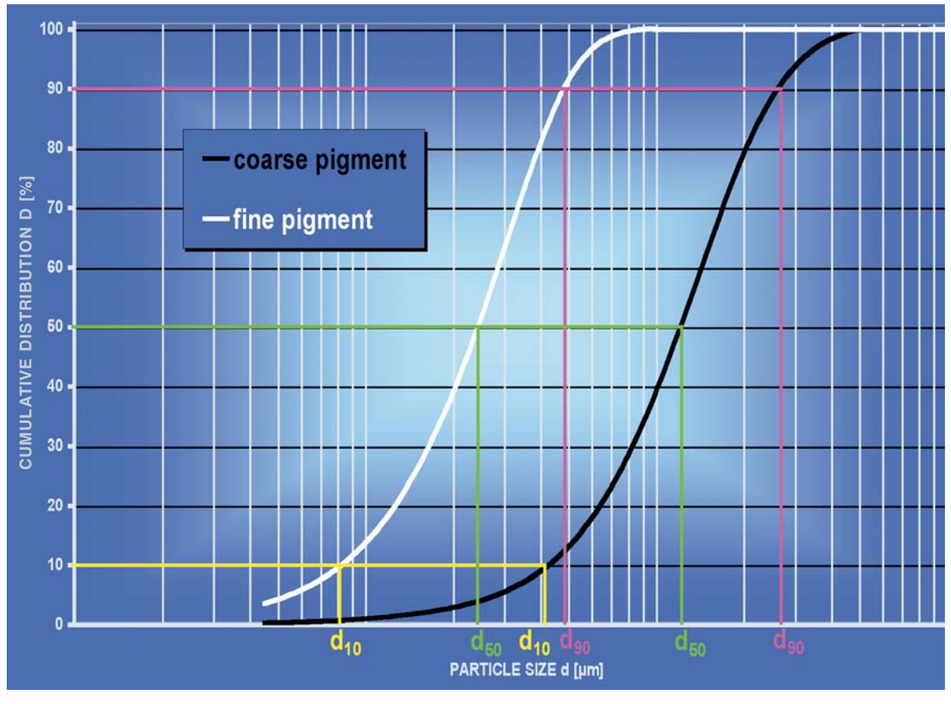


Diagram of the cumulative particle size distribution of fine and coarse aluminium pigments.

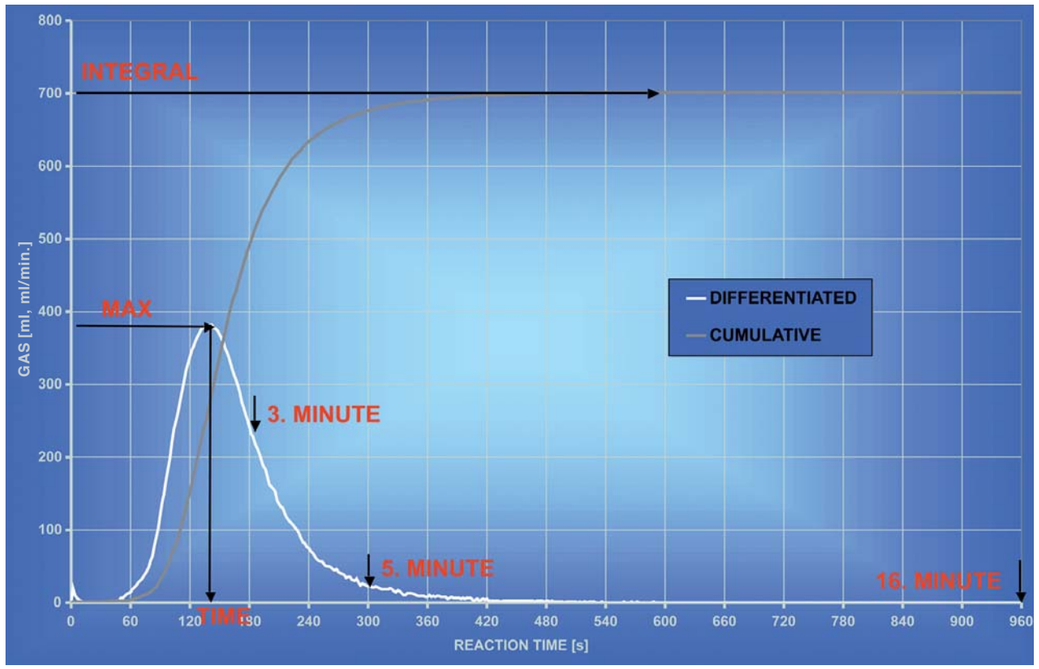


Diagram of the gas reaction: differentiated curve measured by mass flow meter. Cumulative curve calculated from the mass flow meter curve.

ALUMINIUM PASTES

Aluminium pastes are generally free of dust. Their handling thus requires less safety restrictions. They are manufactured with a defined content of aluminium particles. Pastes with 70% of flake content are standard. Other aluminium flake contents are available.

Pastes are generally used to work with aluminium flake / water suspensions. The aluminium suspension typically appears with production technologies using a one-shift withdrawal from a suspension reservoir. This required amount of aluminium suspension is fed casting by casting. Such a technology allows combining the requirement to produce at highest capacity levels with an easy and safe-to handle processing of aluminium flakes.

Diethylene glycol pastes are commonly used in high temperature regions with arid climates or in overseas transport.

Waterborne pastes are very popular within the European region and its neighbouring countries. They disperse very easily into the suspension reservoir and guarantee a high level of homogeneity in the clients' systems, even at highest production rates.

Many parameters characterizing aluminium powders are also valid to define pastes:

- **Median particle size d_{50}**
- **Sieve residue 45 µm**
- **Gas reaction**
- **Solid content**

DESCRIPTION OF GAS REACTIONS

The most important criterion for the use of aluminium powder or aluminium paste is the gas reaction of the pigments. It has to fit the customer's processes perfectly.

Method: The gas reaction is typically measured with a gas volume flow meter. The measured values are defined as hydrogen gas volume set free per minute. The resulting curves are gas reactivity curves, typically defined by a reaction maximum and with zero values at the end of the reaction. There is no need to work with air pressure or temperature corrections.

For comparison reasons, the reactivity curve can be calculated in a cumulative curve representing at any reaction time the total gas volume. These cumulative or sum curves run horizontally at the end of the reaction. They represent the 'historical' volumetric method, whereas pressure and temperature corrections are necessary.

Characteristics: The gas reaction of very reactive aluminium flakes is characterized by a high reaction maximum combined with a strong decrease after that peak (see chart below). The white curve describing this reaction has typically finished after less than 10 minutes respectively 600 sec. Reactive aluminium flakes are used to produce low product raw densities.

The characteristics of moderate reactive aluminium flakes, shown in the black curve, are a low maximum of reaction combined with a long gas reaction, often more than 16 minutes (960 sec). Such flake qualities are typically used to produce high product densities.

Both types of flakes finally generate the same amount of hydrogen gas. Their sum curves must end at the same level.

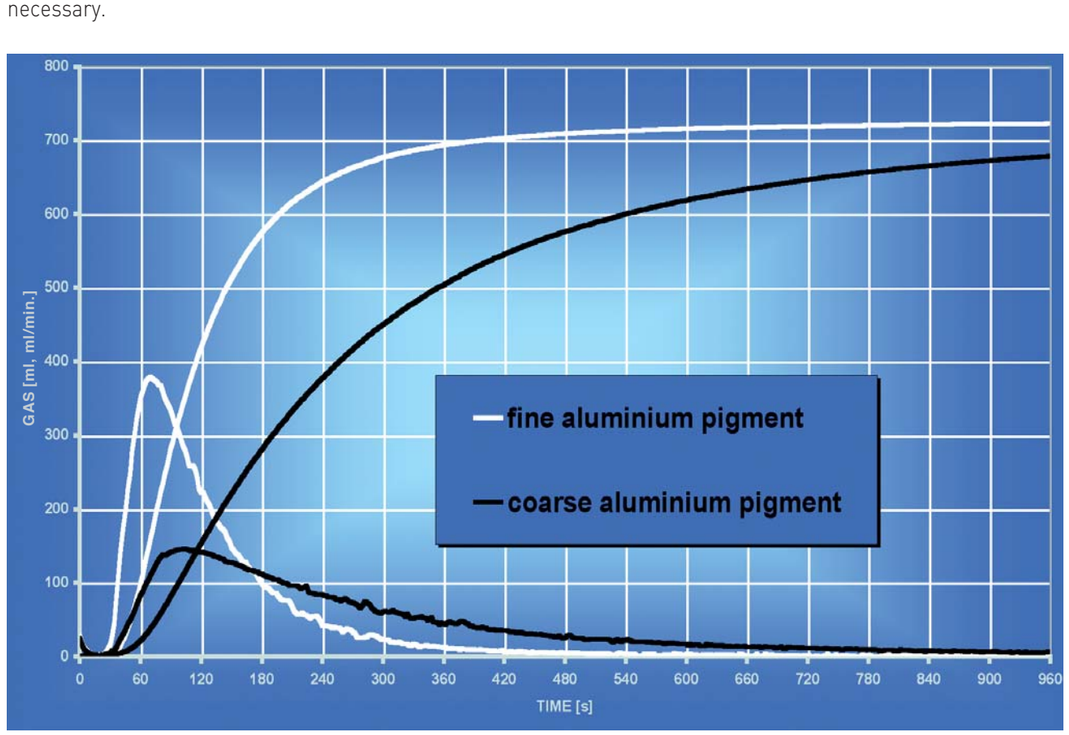


Diagram: differentiated and cumulative reaction curves.

Reaction delay: In addition to the reaction characteristics of the aluminium flakes which are linked to the particle size, a well defined reaction delay can be applied to our products (see chart below). Thus the reaction characteristic can be tailor-made to the client's process without changing the flake fineness.

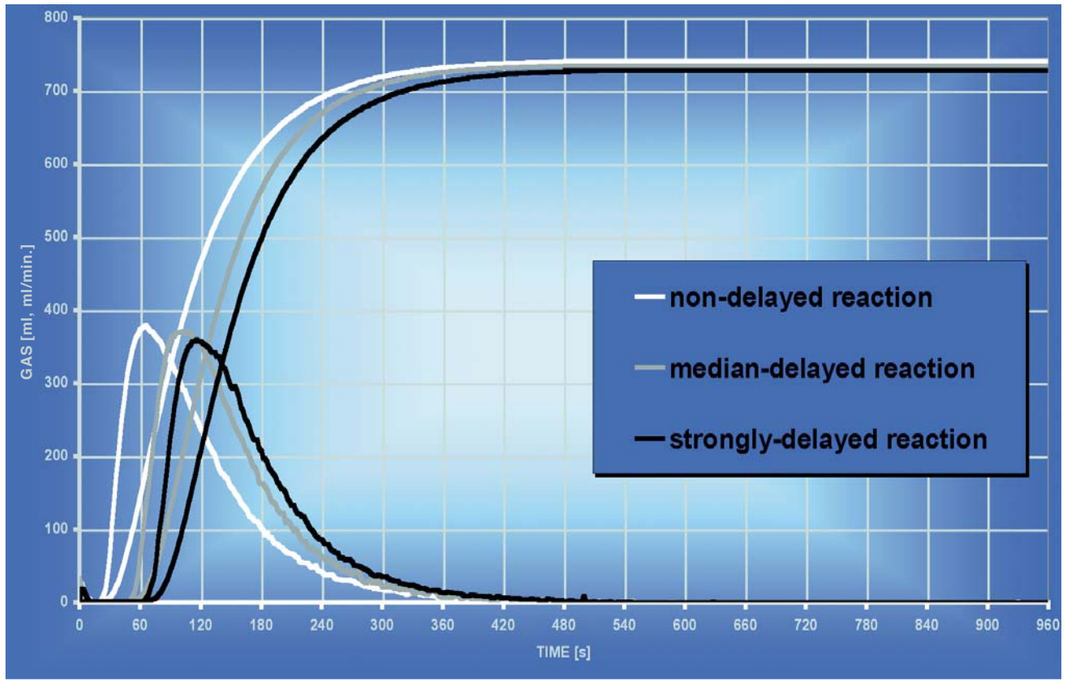


Diagram: gas reaction characteristics of aluminium pigments with different reaction delay.

Modification of Gas Reactions

2.3 Product Groups

2.3.1 Technical Specifications of Powders

Product Name	Bulk density [g/cm³]	Sieve residue*1 45 µm [%]	Mean particle size*2 d_{50} [µm]	Recommended raw density [kg/m³]
7002	0,18 – 0,29	max. 90	approx. 125	> 600
7004	0,20 – 0,29	max. 72	approx. 85	> 600
7304*	0,24 – 0,29	max. 72	approx. 85	> 600
7008	0,15 – 0,19	max. 46	approx. 65	500 - 600
7009	0,15 – 0,19	max. 32	approx. 45	500 - 600
7110	0,12 – 0,15	max. 20	approx. 40	400 - 500
7310*	0,12 – 0,15	max. 20	approx. 40	400 - 500
7112	0,11 – 0,15	max. 12	approx. 30	400 - 500
7114	0,10 – 0,15	max. 10	approx. 30	300 - 450
4102	0,11 – 0,16	max. 35	approx. 45	500 - 600
4402*	0,11 – 0,16	max. 35	approx. 45	500 - 600
4307*	0,13 – 0,15	max. 25	approx. 35	450 - 550
8010	0,12 – 0,14	max. 15	approx. 30	350 - 450
8610*	0,12 – 0,14	max. 15	approx. 30	350 - 450
8013	0,09 – 0,14	max. 5	approx. 25	300 - 450
8014	0,09 – 0,14	max. 2	approx. 22	< 400

Test Methods: *1 – acc. DIN 53 196 *2 – acc. LASER granulometry

*delayed reaction

Our aluminium powders are generally good dispersible in water (< 100 sec.). No extra wetting agent is neccessary.

Active metal content is min. 92%.



Product Name	Bulk density [g/cm³]	Sieve residue*1 45 µm [%]	Mean particle size*2 d_{50} [µm]	Recommended raw density [kg/m³]
77004	0,14 – 0,19	max. 70	50 - 70	> 500
77007	0,13 – 0,18	max. 60	45 - 70	> 500
77010	0,11 – 0,15	max. 20	22 - 30	400 - 500
77012	0,11 – 0,15	max. 8	22 - 27	400 - 500
77212*	0,11 – 0,15	max. 8	20 - 25	400 - 500
77013	0,11 – 0,15	max. 4	20 - 25	400 - 500
77113*	0,11 – 0,15	max. 4	20 - 25	400 - 500
77014	0,11 – 0,15	max. 2	18 - 25	300 - 450
75107	0,20 – 0,28	max. 60	40 - 65	> 500
75110	0,18 – 0,26	max. 20	25 - 32	400 - 500
75210*	0,18 – 0,26	max. 20	25 - 32	400 - 500
75112	0,15 – 0,22	max. 10	20 - 25	400 - 500
75113	0,15 – 0,22	max. 4	20 - 25	350 - 450
76007**	–	max. 60	40 - 65	> 500
76010**	–	max. 20	22 - 30	400 - 500
76012**	–	max. 10	20 - 28	400 - 500
76013**	-	max. 4	17 - 25	350 - 450

Test Methods: *1 – acc. DIN 53 196 *2 – acc. LASER granulometry

*delayed reaction **not wettable

Our aluminium powders are generally good dispersible in water (< 100 sec.). No extra wetting agent is neccessary.

Active metal content is min. 92%.

2.3.2 Technical Specifications of Pastes

Waterborne Systems

Product Name	Sieve residue*1 45 µm [%]	Mean particle size*2 d_{50} [µm]	Recommended raw density [kg/m³]
Aquapor® 100 series	max. 85	70 – 95	> 600
Aquapor® 300 series	max. 70	60 – 70	> 600
Aquapor® 400 series	max. 55	50 – 60	> 600
Aquapor® 4000 series	max. 50	35 – 45	500 – 600
Aquapor® 1000 series	max. 35	25 – 35	500 – 600
Aquapor® 3000 series	max. 20	20 – 30	500 – 600
Aquapor® 8000 series	max. 5	17 – 23	400 – 500
Aquapor® 7000 series	max. 12	15 – 20	400 – 500
Aquapor® 9000 series	max. 5	10 – 15	300 – 450
Aquapor® 11000 series	max. 2	10 – 13	< 400
Aquapor® 4207/W	max. 50	40 – 65	> 600
Aquapor® 4207	max. 50	40 – 65	> 600
Aquapor® 4209/W	max. 25	32 – 45	500 – 600
Aquapor® 4209	max. 25	32 – 45	500 – 600
Aquapor® 4210/W	max. 15	22 – 30	400 – 500
Aquapor® 4210	max. 15	22 – 30	400 – 500
Aquapor® 4213/W	max. 4	17 – 25	350 – 450
Aquapor® 4213	max. 4	17 – 25	350 – 450

Test Methods: *1 – acc. DIN 55 923 *2 – acc. LASER granulometry Solid content – Standard: 70±2%.

Each paste is also available with different solid content and different reaction delay.

Solventborne Systems – Diethylene Glycol

Product Name	Sieve residue*1 45 µm [%]	Mean particle size*2 d_{50} [µm]	Recommended raw density [kg/m³]
DEG/150 series	max. 85	70 – 95	> 600
DEG/350 series	max. 70	60 – 70	> 600
DEG/450 series	max. 55	50 – 60	> 600
DEG/4500 series	max. 50	35 – 45	500 – 600
DEG/1500 series	max. 35	25 – 35	500 – 600
DEG/3500 series	max. 20	20 – 30	500 – 600
DEG/8500 series	max. 5	17 – 23	400 – 500
DEG/7500 series	max. 12	15 – 20	400 – 500
DEG/9500 series	max. 5	10 – 15	300 – 450
DEG/11500 series	max. 2	10 – 13	< 400
DEG 4507/W	max. 50	40 – 65	> 600
DEG 4507	max. 50	40 – 65	> 600
DEG 4509/W	max. 25	32 – 45	500 – 600
DEG 4509	max. 25	32 – 45	500 – 600
DEG 4510/W	max. 15	22 – 30	400 – 500
DEG 4510	max. 15	22 – 30	400 – 500
DEG 4513/W	max. 4	17 – 25	350 – 450
DEG 4513	max. 4	17 – 25	350 – 450

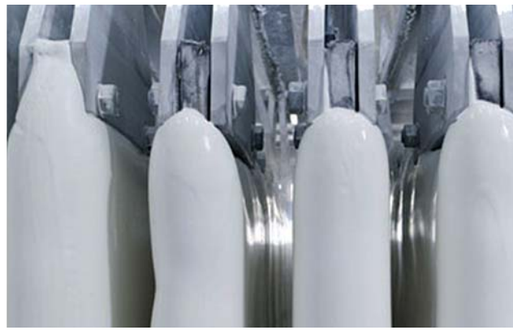
Test Methods: *1 – acc. DIN 55 923 *2 – acc. LASER granulometry Solid content – Standard: 70±2%.

Each paste is also available with different solid content and different reaction delay.









3 Pyrotechnical products and Chemical Industry

3.1 Introduction

Aluminium flakes as a source of energy
Manifold effects – reliable quality guaranteed

The traditional fields of application for aluminium flakes include the use as a reaction agent to control reactions of pyrotechnical products. They ensure controlled and effective reactions at very high speed. Pyrotechnical products create defined sound, light or explosive effects. Explosives specifically require highly reactive kinds of powder. Among these, we can also identify the production of civil explosives, which are mainly used in the mining industry. What matters here are the correct mixture and the exact particle size of the flakes: coarse, middle or fine.
The slurry explosives rate among the safety explosives. They have a gel-like or sludge-like consistency. They are easy to handle and they are commonly used in civil explosives.
Thin aluminium flakes with lower surfaces, so-called tinsel (=flitters) are ideally suited to creating light effects. They are part of various pyrotechnical products: in rockets and firecrackers for impressive fireworks as well as for the illumination of objects and stages. They are also used in illuminants and effect lights.
The crucial point about all fields of application, be it open-air fireworks or mine blasting is, that the moment and the process of the reaction can be exactly defined. This requires premium aluminium flakes – and that is exactly what Schlenk constantly provides in top quality. This ranges from the procurement of selected raw materials to the excellent safety standards which we pass on to our clientele.

Aluminium powders and foil granules as energy source and reducing agent within the Chemical Industry

The energy-rich reaction of aluminium is used as a heating source by the Chemical Industry in exothermic sleeves. The aluminium powder as a component in the sleeves supplies the energy through its exothermic oxidation reaction to keep the molded metal as molten mass. In its second function, the aluminium powder prevents the oxidation of the molten metal at the sleeve wall due to its reduction properties.
The Chemical Industry benefits from the high reduction potential of aluminium products in further applications. Aluminium powder mixtures also in combination with foil granules are used as reducing agent with cinders during the smelting process. Aluminium flakes help as pastes to create pure white titanium dioxide pigments during the acidic sulphate process. Here it is important to completely reduce the trivalent iron (and other colouring metals) into the colourless form.
It is the aim to achieve a pigment as pure white as possible which can be found for instance in exterior façade coatings or paints.

3.2 Product Properties and Test Methods

Schlenk takes great efforts to guarantee a constant level of high product quality. A selection of critical quality tests has to be completed regularly to ensure this.
The most important test methods for Pyrotechnical and Chemical Industry aluminium powders, for both defining property characteristics and quality, can be found below:

Active metal content

This method determines the amount of reactive aluminium by measuring the gas volume generated in the chemical reaction of aluminium powder with alkaline solution. The results are always counterchecked by a simultaneous measurement of high purity aluminium powder.

Acetone extract

The acetone extract represents the quantitative evaluation of organic components on the particle surface.
The extraction is made by means of the solvent acetone. The content of the organic fraction is determined upon vaporization of the solvent by weighing the residue.
The applied amount of fatty acid organic material on the flake surface determines the reaction characteristics of the pyrotechnical products.

Mean particle size – Particle size distribution

Particle size diffraction is measured by a LASER granulometer. The average grain size is specified as d_{50}-value. Complete particle size distribution of the aluminium flake paste for titanium dioxide production influences the efficiency in the sulfuric acid process of our clients. Flakes are generally manufactured according to customer requirements.

Sieve residue

The determination of the sieve residues on different sieve sizes up to 1,000 microns is an important test to characterize the different powder products for each application such as pyrotechnics, exothermic sleeves or slag deoxidants.

Bulk density

The bulk density and the sieve values together make up the most significant and decisive quality parameters of all aluminium powder products (i.e. from flakes and spherical particles to flitters).

Combustion time

This quality parameter defines the speed of the reaction kinetics of an aluminium powder. First, a defined mixture of the aluminium powder with potassium perchlorate has to be created. That mixture needs to be compacted in a paperboard core. After the mixture is ignited the burning time, in seconds, is measured.

3.3 Product Groups

3.3.1 Specifications of Pyrotechnical Aluminium Powders

Product Name	Active metal content*1 [%]	Acetone extract*2 [%]	Mean particle size*3 d_{50} [µm]	Sieve residue*4 >71 µm >210 mesh [%]	Sieve residue*4 >40 µm >350 mesh [%]	Bulk density*5 [g/cm³]	Combustion time*5 [s]	Application
UP/80	min. 80	max. 0,1	approx. 15	max. 1,0	max. 10	0,66-0,76	6-7	
UP/70	min. 80	max. 0,1	approx. 20	max. 5,0	max. 25	0,30-0,50	7-9	
UP/50	min. 80	max. 0,1	approx. 30	max. 15	max. 40	0,30-0,40	10-12	
THM*	min. 90	max. 0,1	approx. 15	max. 1,0	max. 10	0,40-0,50	6-8	
THD*	min. 90	max. 0,1	approx. 15	max. 1,0	max. 10	0,56-0,66	< 7	
M3	min. 80	max. 0,1	approx. 12	max. 1,0	max. 10	0,56-0,66	6-8	
WK/70-III	min. 80	0,30-0,40	approx. 12	max. 1,0	max. 15	0,30-0,40	> 8	
NX17	min. 80	max. 0,1	approx. 10	max. 1,0	max. 10	0,50-0,66	5-6	
No. 90	min. 80	max. 0,25	approx. 15	max. 5,0	max. 20	0,46-0,56	–	
PC 603	min. 80	max. 0,1	approx. 15	max. 1,0	max. 10	0,56-0,66	–	
10083	min. 90	–	approx. 40	–	–	0,34-0,38	–	
VP/10083/F	min. 90	–	approx. 55	–	–	0,40-0,44	–	

Test Methods: *1 – acc. hydrogen volume *2 – acc. acetone extract as per Soxhlet *3 – acc. LASER granulometry
*4 – acc. DIN 53 196 *5 – acc. internal method

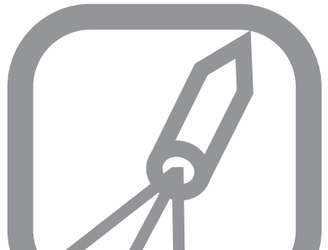
*On customers request, this powder can be delivered according TL specification.

According to customers request, also individual products can be developed and produced.

3.3.2 Technical Specifications of Aluminium Powders for Slurries (Civil Explosives)

Product Name	Water Coverage*1 [cm²/g]	Screen Analysis*2 >71 µm [%]	Screen Analysis*2 >45 µm [%]	Fat Content*3 [%]	Application
SL/0770	min. 18 000	max. 1	max. 7	2-3	
SL/0970	min. 20 000	max. 0,5	max. 3	2-3	
SL/2770	min. 18 000	max. 1	max. 7	2-3	
SL/2970	min. 20 000	max. 0,5	max. 3	2-3	
SL/4930 DD	min. 20 000	max. 0,5	max. 3	2-3	
SL/4970 DD	min. 20 000	max. 0,5	max. 3	2-3	
SL/41130 DD	min. 20 000	–	max. 1	2-3	

Test Methods: *1 – acc. DIN 55 923 *2 – acc. DIN 53 196 *3 – acc. DIN 55 923



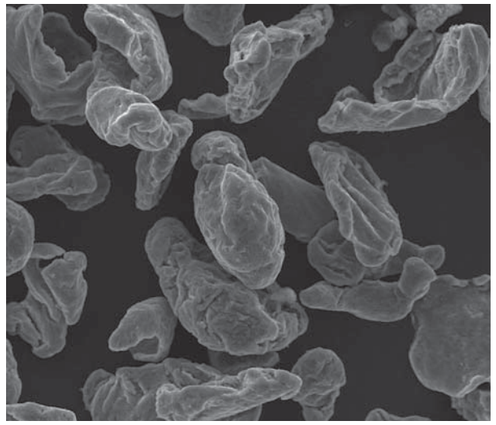
3.3.3 Specifications of Aluminium Flitters

Product Name	Bulk density*1 [g/cm³]	Acetone extract*2 [%]	Active Metal content*3 [%]	Typical particle size*4 [µm]	Application
0/150	approx. 0,40	max. 0,6	min. 92	0-150	
0/300	approx. 0,40	max. 0,6	min. 92	0-300	
150/300	approx. 0,40	max. 0,6	min. 92	150-300	
0/600	approx. 0,40	max. 0,6	min. 92	0-600	
300/600	approx. 0,40	max. 0,5	min. 92	300-600	
600/1000	approx. 0,40	max. 0,5	min. 92	600-1000	
1000/1600	approx. 0,40	max. 0,5	min. 92	1000-1600	

Test Methods: *1 – acc. internal method *2 – acc. acetone extract as per Soxhlet
*3 – acc. hydrogen volume *4 – acc. DIN 53 196

3.3.4 Specifications of Foil Granules

Schlenk manufactures high quality aluminium foil granules from unlaminated aluminium foils or from foils laminated with paper. These very specific aluminium granules are mainly used in foundry technologies, in explosives or in chemical industries. Because of the special manufacturing process, the granules typically consist of irregular clew particles, with active metal contents of approx. 96 % and high bulk densities of approx. 1 g/cm³.



Our standard granules are available with the following particle size ranges:

0 / 106 µm
106 / 160 µm
160 / 315 µm
315 / 630 µm
630 / 1000 µm

We can also provide customers with any blends of the standard granules, passivated or non-passivated.

