EVONIK INDUSTRIES

SIPERNAT® and AEROSIL® – an essential in industrial powder technology

Technical Information 1360

Evonik. Power to create.

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Introduction

Drying, conveying, dosing and various other ways of powder-handling are everyday's business in the chemical, food, feed and pharmaceutical industry. Problems, such as blockage of filters or conveying systems, inaccurate dosing of ingredients or clogging of dryers and mills caused by bad flowing or caking material can cause costly shut downs in production and – even worse – undesirable variation in quality. Other processes require accurate dosing of liquids into a powdery formulation. However, dispersing the liquid homogeneously into the powder is often a challenge, especially if the liquid is highly viscous or a small amount of the liquid needs to be added to a large amount of powder. In these cases it is advantageous to convert the liquid into a powder, enabling a much more precise dosage and homogeneous distribution.

Silicon dioxide manufactured by Evonik, namely SIPERNAT® and AEROSIL® products, facilitates all these processing steps significantly, as it helps to ensure flowability of powders, minimizes caking or converts viscous liquids into free flowing powders.

Benefits of SIPERNAT® precipitated silica and AEROSIL® fumed silica:

Flow improvement: Both, SIPERNAT® and AEROSIL® products improve flowability of powders, avoiding blockage during conveying, dosing or filling of your product.

Milling aid: Incorporation of SIPERNAT® or AEROSIL® grades during grinding of low-melting powders makes your milling more efficient as it reduces clogging of the mill.

Anticaking: When a SIPERNAT® or AEROSIL® grade is admixed, your powdered material remains freely flowable even when stored under pressure and/or at varying ambient conditions.

Carrier: SIPERNAT® precipitated silica converts additives that usually appear as liquid or pasty substance into free flowing powders, which can be processed, handled and stored very easily.

Drying aid: Adding AEROSIL® or SIPERNAT® specialty silica to a powder in the moment it is generated from solution, i. e. during spray drying, reduces caking of the material at the inner wall of the dryer. This extends the operating hours between two cleaning downtimes.

The Evonik portfolio comprises two different ways to manufacture specialty silica:

- **SIPERNAT®** grades are produced in a wet process by precipitation and subsequent drying and –in some cases– milling down to different particle sizes.
- **AEROSIL®** grades are made in a dry process by flame hydrolysis.

The two methods as well as the conditions set-up during each process lead to different structures and characteristics. For example the optimum combination of the size of aggregates and agglomerates, surface area, absorptive capacity, pH value, etc. produces various silica types ideal for a range of applications.

In an additional step some of the grades are rendered hydrophobic by a chemical surface treatment.

1 SIPERNAT® and AEROSIL® to improve powder characteristics

1.1 SIPERNAT® and AEROSIL® to ensure flowability and prevent caking of powders

In various powdered materials SIPERNAT® and AEROSIL® types are capable of inhibiting the formation of hard agglomerates or lumps effectively ensuring a good flowability of the material and therefore improve handling and processing of the powder.

As reason for poor flow characteristics and high caking tendency of powdered materials are multifaceted: the solutions must be adapted individually to the product and its manufacturing process.

The main reasons for decreased flowability and caking of powder particles are:

Reasons for caking and bad flowability:

- **Liquid film:** Liquid layers (water, oil, etc.) on the surface of particles form liquid bridges and thus lead to strong adhesion between these particles.
- **Particle size:** Fine powders tend to cake more than coarser materials do.
- **Particle shape:** Irregular shape and high surface roughness "hooks" the particles together.
- **Plasticity:** Malleable, soft powders stick when pressure is applied or at higher temperature.
- **Electrostatic charging:** Charged particles especially stick to the inner walls of containers and hoppers, so emptying the container becomes difficult.

Detailed and fundamental information on how silica performs as flow and anticaking aid are given in our Technical Information TI 1351 "SIPERNAT® and AEROSIL® as Flow Aid and Anticaking Agent".

It has been demonstrated, how versatile the functions of SIPERNAT® and AEROSIL® Specialty Silica are when improving flowability of powders and avoiding caking of those. It can be easily imagined that several factors, such as the nature of the respective material, type of silica used, dosage, order of mixing the ingredients and shear forces, which are applied during mixing, have a crucial influence on the final result. Especially the method of mixing the silicon dioxide with the host powder is important. Further information on appropriate mixing technology is given by Evonik in the Technical Information TI 1213 "Performance Silica as Flow Agent and Carrier Substance–Recommended Mixing Procedures for Powders and Granulates".

Some basic rules for choosing and processing the right silica are summarized in **Table 1**. Besides flow- and caking characteristics of the powder another important aspect is its dustiness, which makes handling difficult and inconvenient. In order to achieve a minimum level of dust, the type of flow- or anticaking aid as well as the mixing conditions must be chosen carefully. Application specialists with long years of experience at Evonik are prepared to support each customer individually by selecting the appropriate silica type and mixing procedure.

Table 2 on page 5 provides some examples of the versatile options SIPERNAT® and AEROSIL® grades offer.

Table 1 Recommendation matrix for silica-usage and mixing technology

	Dry, hard powders	Wet, hard powders	Soft powders
Type of silica	Use silica which can be dispersed easily	Use mechanically stable, highly absorptive silica	Use silica which can be dispersed easily
Addition level	Low addition level, often <1 %	Addition level adapted to the amount of liquid	High addition level, especially if anticaking is needed, up to 5 %
Mixing	Intensive mixing	Gentle mixing	Moderate mixing: Disperse the silica, but do not destroy the soft powder

Table 2 Application examples for silica used as flow and anticaking aid

Application	Recommended Types of Flow- / Anticaking Aids
Acrylic polymers	SIPERNAT® 22 S, -D 10, AEROSIL® R 812
Adhesives	SIPERNAT® 22 LS, AEROSIL® 200
Amidosulphonic acid	AEROSIL® 200 or SIPERNAT® 22 S
Amino acids	SIPERNAT® 22 S, 50 or 50 S
Antioxidants	SIPERNAT® 22 S or 50 S, AEROSIL® 200 F or Pharma
Cappuccino powder	SIPERNAT® 22 S or AEROSIL® 200 F
Cellulose ethers	SIPERNAT® 22 S, 50 S or 320
Cellulose powder (pharma)	AEROSIL® 200 Pharma
Cheese powdered / grated	SIPERNAT® 22 S or AEROSIL® 200 F
Choline chloride powder	SIPERNAT® D 17
Citric acid	AEROSIL® R 812 or SIPERNAT® D 10
Cocoa powder	AEROSIL® 200 F or 380 F
Cyanuric chloride	SIPERNAT® D 17 or D 10, AEROSIL® R 974
Dicyan diamide	SIPERNAT® D 17 or D 10
Dragees, capsules, tablets (Pharma)	AEROSIL® 200 Pharma, AEROSIL® R 972 Pharma
Egg powder	SIPERNAT® 22 S, 50 S or AEROSIL® 200 F
Explosives	SIPERNAT® 22 S, D 17 or D 10, AEROSIL® R 972
Feed Minerals and their premixes	SIPERNAT® 22 S, 50 S or D 17
Fertilizers	SIPERNAT® 320 or 22 S
Fire extinguishing powders	SIPERNAT® D 17 or D 10, AEROSIL® R 972 or R 812
Flavonoids	SIPERNAT® 22 S or 50 S, AEROSIL® 200 F or Pharma
Fruit powders	SIPERNAT® 22 S or 50 S, AEROSIL® 200 F or 380 F
Guar gum	SIPERNAT® D 17 or 22 S (technical), SIPERNAT® 22 S (food)
Gypsum	SIPERNAT® D 17
Hexamethylene tetramine	SIPERNAT® 22 S, 50 S or 320, AEROSIL® R 812
Icing sugar	SIPERNAT® 350 or AEROSIL® 200
Impact modifiers for PVC and PE (e.g. CPE)	SIPERNAT® D 17, AEROSIL® 200 or R 972
Inorganic salts	AEROSIL® R 812, R 972 or SIPERNAT® D 17, SIPERNAT® 22 S, 50 S, 320 DS or AEROSIL® 200
Instant coffee	SIPERNAT® 22 S or AEROSIL® 200 F
Instant soups, sauces, desserts	SIPERNAT® 22 S or 50 S, AEROSIL® 200 F
Iron sulphate heptahydrate	SIPERNAT® 22 S, 50 S, D 17
Latex powder	SIPERNAT® D 17
Leveling agents	SIPERNAT® 120, 360 or 820 A, AEROSIL® OX 50
Metal oxides	AEROSIL® R 812 or R 972
Methacrylates (powder)	SIPERNAT® 22 S, -D 10, AEROSIL® R 812
Milk replacer	SIPERNAT® 22 (S) or 50 (S)
Mortar mix (dry)	SIPERNAT® 360 or 22 S
Permanganate	SIPERNAT® 22 LS, AEROSIL® 200, R 812 or R 8200
Phosphates	AEROSIL® R 812 or R 972
Pigments	AEROSIL® R 812, R 8200 or R 972
Plaster	SIPERNAT® 22 S, 820 A or D 17, AEROSIL® 130 or R 972
Polyphenols	SIPERNAT® 22 S, 50 S or AEROSIL® 200 F
Powder coating	AEROSIL® 200 or AEROXIDE® Alu C 805, AEROSIL® R 972, AEROXIDE® Alu C
Powdered fruit drinks	SIPERNAT® 22 S or AEROSIL® 200 F
Protein hydrolyzates	SIPERNAT® 22 S, 50 S or AEROSIL® 200 F
Polyvinyl alcohol (PVA), Polyvinyl acetate (PVAc)	SIPERNAT® 22S or 50 S, SIPERNAT® D 17, AEROSIL® R 812
Polyvinyl chloride (PVC)	SIPERNAT® D 17 or D 10, AEROXIDE® Alu C
Redispersible powders	SIPERNAT® 22 S or 50 S, SIPERNAT® D 17
Rubber recycling powder	SIPERNAT® 22 S or 50 S
Sodium bicarbonate	SIPERNAT® 22 S or 50 S, SIPERNAT® D 17 or AEROSIL® R 972
Soap powder	SIPERNAT® 22 S or 50 S
Spices and seasonings	SIPERNAT® 22 S or 50 S, AEROSIL® 200 F or 380 F
Starch (food grade)	SIPERNAT® 22 S or AEROSIL® 200 F
Starch (technical)	SIPERNAT® 22 S or 22 LS, AEROSIL® R 8200 or R 812, AEROXIDE® Alu C
Sulphur	SIPERNAT® 22 S or D 17, AEROSIL® R 972
Table salt	SIPERNAT® 22 S
Thermoplastic elastomers (TPE, TPU)	AEROSIL® R 972 or 200, SIPERNAT® 350
Toilet cleaner	SIPERNAT® 50 S or 22 S
Tomato powder	AEROSIL® 200 F or 380 F
Unsaturated polyester (UPE)	SIPERNAT® 22 LS, 320 DS or 22 S
Urea (Feed)	SIPERNAT® 50 S or 22 S
Vinyl acetate ethylene copolymer (VAE)	SIPERNAT® 22 S, 50 S or D 17
Vitamins and their premixes (feed)	SIPERNAT® 22 S, 50 S or D 17
Waxes (micronized)	AEROSIL® R 8200 or 200, SIPERNAT® 22 LS
Whirl sintering powder	AEROSIL® R 972 + AEROXIDE® Alu C
Yeast powder	SIPERNAT® 22 S or 50 S, AEROSIL® 200

1.2 SIPERNAT® and AEROSIL® as drying aid

The most effective way to render a spray dried powder free flowing is dosing the silica directly into the spray drier. Here the powder particles are wrapped into the flow aid at the moment they form during the drying process before they get into close contact and start growing together. The earlier a powder is treated with the Specialty Silica the more effective it works as anticaking aid. **Figure 1** shows the different options where to dose the silica into a spray dyer.

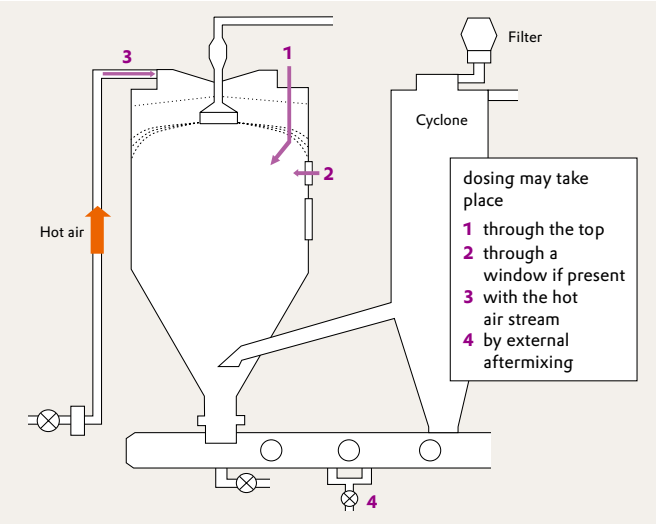


Figure 1 Schematic drawing where to add silica into a spray dryer

Thus the preferred way of dosing SIPERNAT® or AEROSIL® types into a spray dryer is option 1 or 2. The flow aid is added separately from the liquid product either through the top or –if available– a window in the side wall of the dryer in the wet-zone. There the silica comes in contact with the powder and coats it just in the moment the dry particles are built. This does not prevent the powder from further drying. Other ways to dose the silica is with the hot air stream (addition point 3) or immediately after the material leaves the dryer (addition point 4). However, the latter option requires an additional mixing step.

An additional advantage of using flow aids directly in the dryer is a reduction of caked material at the inner wall that possibly clogs the same. Therefore often longer operating intervals and less cleaning downtime are required. Thus SIPERNAT® precipitated silica or AEROSIL® fumed silica can help to increase productivity of your plant significantly.

In some cases it might be beneficial to add silica to the dryer in the liquid phase. This modifies the formation of droplets in the dryer with liquids that otherwise are difficult to spray. The silica forms a matrix for the liquid which helps it to form discrete droplets. This method therefore helps during spray drying, but it gives an inferior anticaking effect compared to the other mentioned ways of applying Specialty Silica into a spray dryer. The reason therefore is the incorporation of most of the silica inside the droplets instead onto the surface of the resulting powder.

Besides spray drying, Specialty Silica can be used advantageously in other processes, such as spray cooling, drum drying, etc.

There is a wide range of applications that can benefit. **Table 3** gives some examples.

1.3 SIPERNAT® and AEROSIL® as milling aid

When low melting powders or products with a high liquid content are milled, this often leads to caking of material in the mill. As a result clogging may occur. To reduce time- and cost consuming cleaning intervals, SIPERNAT® or AEROSIL® grades can be added during the grinding process. The surface of the finely milled powder is coated with the silica immediately. Promptly, any released liquid is absorbed and consequently agglomeration of these particles is inhibited. Besides good powder flow, the mill remains cleaner for longer operation time and the throughput increases. **Figure 2** demonstrates this effect in a hammer mill.

Untreated Chili Powder | Milled with SIPERNAT®

Figure 2 Example of Chili Powder in a hammer mill untreated (**left**) and treated (**right**) with SIPERNAT® precipitated silica

Table 3 Application examples for silica used as drying aid

Application	Examples	Recommended Types of Drying aid
Dairy products	Milk powder Whey powder	SIPERNAT® 22 SIPERNAT® 22 S AEROSIL® 200 F
Fruit- and vegetable powder	Tomato powder	AEROSIL® 200 F AEROSIL® 380 F
Plant extract	Pigments,Ingredients for nutraceuticals	AEROSIL® 200 F
Polymer Powder	Latex powder Vinyl acetate ethylene (VAE)	SIPERNAT® D 17 SIPERNAT® 22 S SIPERNAT® 50 S

The use of Evonik Specialty Silica is beneficial for hammer mills, pin mills or alike.

Applying the silica this way is especially convenient, as the fine powder is already coated with silica after the milling process, which improves the flow-characteristics of the material for the following processing steps.

In **Table 4** some application examples are listed:

Table 4 Application examples of silica used as milling aid

Application	Examples	Recommended types of milling aid
Agrochemicals	Wettable powder	SIPERNAT® 320
Chemical products	Recycled rubber Sulphur	SIPERNAT® 22 S or 50 S SIPERNAT® 320
Food	Chili powder Herbs Spices	SIPERNAT® 50 or 50 S SIPERNAT® 22 or 22 S

2 SIPERNAT® as carrier of various liquids

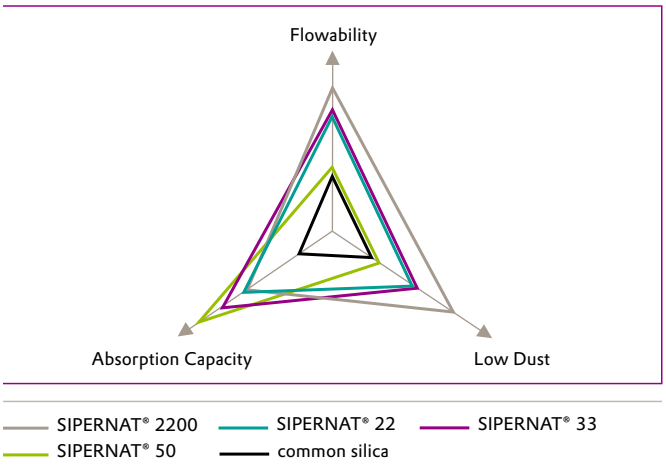
Precise dosing of liquid ingredients into a powder blend often is a challenging procedure, especially when these liquids are highly viscous or sticky. Converting these liquids into free-flowing powders by using carrier silica offers a perfect answer to these challenges. These powders in the industry often are referred to as Dry Liquids. They can be dosed exactly and handled easily without sticking to the equipment. By choosing the right silica grade a non dusty absorbate can be produced with a good mixing technology. Dust free powders are not only more convenient, but also demanded when the liquid is irritating or even toxic.

The flow- and dust characteristics of the final product are determined by the flow properties of the carrier silica used. Here the particle size distribution of the carrier is important. A coarser particle size generally corresponds with better flowability and lower dust of the resulting product.

The amount of liquid that can be absorbed is is a silica own property and predetermined by its production conditions. The so-called DOA value allows to compare different silica grades regarding their absorption capacity. However, the real liquid uptake depends on further parameter (e.g. liquid viscosity, wetting behavior, etc.) and has to be checked for each application.

Figure 3 compares various types of carrier silica with their corresponding properties. Evonik offers further information on various types of carriers in written form.

Figure 3 Important characteristics of various carrier silica



Besides selecting the right silica type and concentration, the method of applying the respective liquid to the carrier is of utmost importance. Detailed information on this issue can be found in the Technical Information TI 1213 "Performance Silica as Flow Agent and Carrier Substance-Recommended Mixing Procedures for Powders and Granulates."

Furthermore, our technical specialists are happy to support you individually and perform tests in our application lab.

Table 5 gives some examples for the application of SIPERNAT® and AEROSIL® grades used as carrier:

Table 5 Application examples for silica used as carrier

Application	Recommended Type of Carrier Silica
Acidifiers	SIPERNAT® 22 or 2200
Adhesion promotors	SIPERNAT® 22, 33 or 50
Antioxidants	SIPERNAT® 22 or 2200
Antistatics	SIPERNAT® 33, 22 S, 22 LS or 320 DS
Choline chloride (75%)	SIPERNAT® 22
Concentrates of active ingredients	SIPERNAT® 22 (S) or 50 (S)
Curing agents	SIPERNAT 22, 33 or 50
Emulsifier	SIPERNAT® 2200
Enzymes	SIPERNAT® 50
Ethoxiquin	SIPERNAT® 22
Fat concentrates	SIPERNAT® 22 or 2200
Flavors	SIPERNAT® 22 S or 50 S, AEROSIL ® 200 F
Formic acid	SIPERNAT® 22
Hops extract	SIPERNAT® 22
Lactic acid	SIPERNAT® 22 or 2200
Leveling agents (liquid)	SIPERNAT 22, 120 or 360
Marigold extract	SIPERNAT® 22 or 2200
Melamine resins	SIPERNAT® 22 or 33
Methacylates	SIPERNAT® 22, 33, or 50
Molasses	SIPERNAT® 22
Mortar additives (liquid)	SIPERNAT® 22 S
Organo silanes, silanes	SIPERNAT® 22, 33 or 50
Oxygen absorbers	SIPERNAT® 22 S, 50 S, 320 DS, 22 LS or 500 LS
Perfume oils and fragrances	SIPERNAT® 22 (S) or 50 (S) or 33
Peroxides (organic)	SIPERNAT® 22, 320 or 2200
Pigment pastes	SIPERNAT® 22, 50 or 2200
Plant and vegetable extracts	SIPERNAT® 22 or 50, AEROSIL® 200 F or 200 Pharma
Plastic additives	SIPERNAT® 22 (S), 33 or 50 (S)
Plasticizers	SIPERNAT 33, 22 S, 22 LS or 320 DS
Powder defoamer	SIPERNAT® 22, 33, 50 or 2200
Propionic acid	SIPERNAT® 22
Resins	SIPERNAT® 22 S, 50 S, 320 DS, 22 LS or 500 LS
Rubber additives	SIPERNAT® 22 (S), 33 or 50 (S)
Silicon oil	SIPERNAT® 22, 33, 50
Stabilizers	SIPERNAT® 22, 33 or 50
Triallyl cyanurate (TAC)	SIPERNAT® 22, 33 or 50
Vitamin E acetate	SIPERNAT® 22 or 2200
Waterdispersible granules	SIPERNAT® 22 (S) or 50 (S)
Wetting agents	SIPERNAT® 22S or 50 S
Wettable powders	SIPERNAT® 22 (S) or 50 (S)

3 Methodology to determine flow and carrier characteristics

When processing powders, the most important handling properties are the flowability and the caking tendency. The flowability determines whether a powder can be conveyed easily and dosed accurately. The caking tendency describes whether the powder remains free flowing after storage or transport. Another important aspect for working with powders is their tendency to form dust, especially when emptying bags or packing product.

For Dry Liquids, of course the concentration of the active ingredient is important which is defined by the absorption capacity of the corresponding silica.

The following table lists some practical rapid tests that are used to characterize these properties of powdered materials.

Table 6 Methods to determine powder characteristics

Parameter	Method
Flow behavior	- Angle of repose - Flow grade by means of funnels
Caking	- Scrape test
Dust	- Optical measuring with e. g. CIPAC MT 171
Absorption capacity	- Dioctyl adipate absorption (DOA-number) - Maximum absorption under pressure

3.1 Flow behavior:

As a basic indication how to take material out of a stock device, hopper or conveyor, the “angle of repose” is used as the measure. In this case, the powder passes through a sieve and falls on the top of a solid metal cylinder which causes the powder to form a cone. When particles fall on the cone, their cohesiveness determines whether they stick on the cone or follow gravity and roll down the cone. This leads to a cone with fixed height and slope. Measuring the angle or the height of the cone on a fixed diameter of a metal cylinder gives a measure for flowability. The lower the cone height, the better is the flowability. **Figure 4** illustrates this; the material on the left cylinder is less flowable compared to the right one.

Figure 4 Measuring the angle of repose or cone height on a steel cylinder

Figure 6 Steel cylinder to determine caking tendency

Alternatively a quick method is to measure the flow grade by means of flow funnels. Here, a defined set of flow funnels with different outlet diameters is used as shown in **Figure 5**. Again, the powder on the right side of the picture has an improved flowability versus the left one. This analysis determines whether the powder still flows out of the funnel completely without any blockages or not.

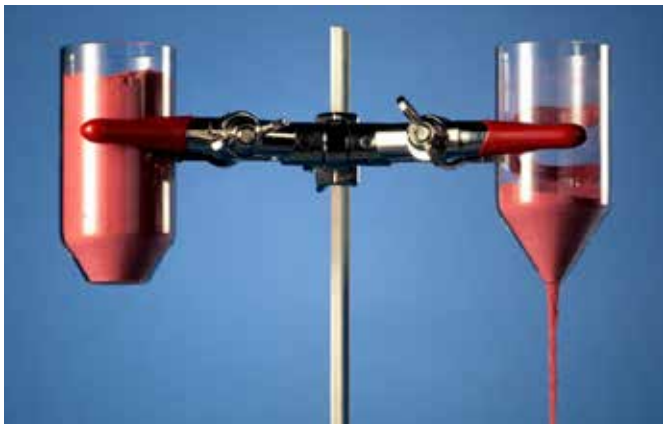


Figure 5 Flow funnels to determine flow grades

3.2 Caking tendency:

Bags of powdered product are very often stacked on top of each other. The pressure that is applied to the material, especially on the bottom layer, may lead to formation of lumps. In order to estimate the "stacking resistance" the following test can be used:

The relevant material is poured into a steel sleeve with defined inside diameter. To provoke caking an exactly fitting cylinder with defined weight is inserted as shown in **Figure 6**. If necessary some additional weight can be used to simulate higher pressure. The duration of the compression load as well as storage conditions, such as high temperature or high humidity can be simulated in a climate chamber.

After storage, the weight and the cylinder are removed carefully. The force that is needed to scrape off a certain layer of the densified bulk can be measured and gives an indication of the caking strength.

3.3 Dust:

One key objective, when developing a powder formulation is to reduce or avoid dustiness of the material. Therefore measuring the dust generated by the powder is important. This can be done by the use of optical methods determining the attenuation of light in a dust laden atmosphere.

Figure 7 gives an example for such a test-setup. The sample is poured into the hopper on the top of the device. When the measurement is started, the valve opens and the powder falls into the measuring device. The attenuation of light by the dust is measured. Furthermore, the dust settling behavior over time can be determined.

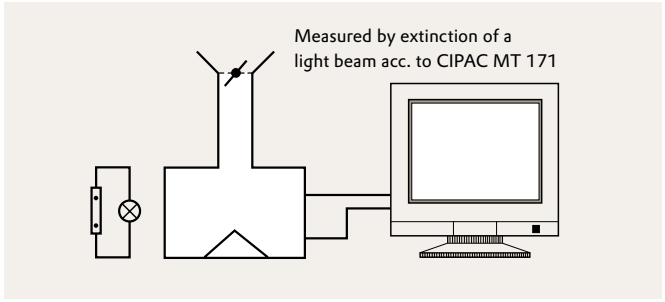


Figure 7 Model of dust measurement by optical method

3.4 Absorption capacity:

When silica is used for carrier applications, the absorption capacity is an indicator for the amount of active ingredient, which can be converted into a free flowing powder.

Besides the standardized method of measuring the **Dio**ctyl **a**dipate absorption (DOA-number) with specialized equipment, a practical rapid test is to determine the maximum absorption under pressure. In this test, the relevant absorbate is placed into a steel sleeve also used for measuring caking tendency (see. 3.2). A filter paper is placed directly beneath the sample to absorb the liquid pressed out. After a defined period of time, the filter is weighed and the amount of released liquid is determined.

By incrementally increasing the concentration of liquid on the carrier and measuring the amount of liquid released, the maximal absorption under the applied pressure is determined. **Figure 8** illustrates the test design.

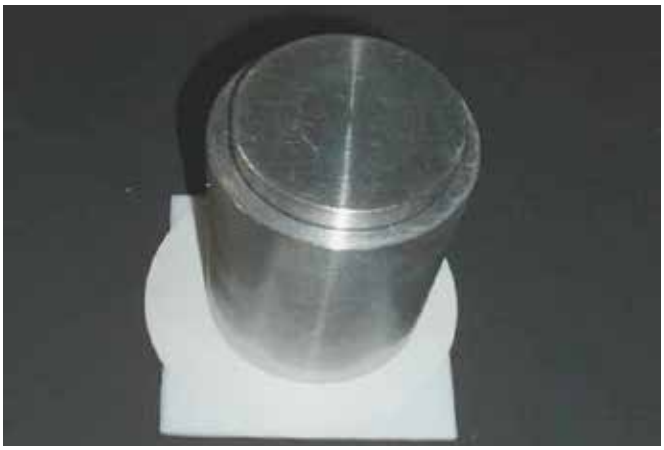


Figure 8 Steel cylinder on a filter paper to determine absorption capacity

4 Quality and legal aspects

For specially regulated industries certain grades of AEROSIL® fumed silica and SIPERNAT® precipitated silica are available.

For example, with regard to the food and feed manufacturers, there are special SIPERNAT® and AEROSIL® types available which are HACCP compliant and FAMI-QS-certified and comply with the EU- Regulations No. 852/2004 and 183/2005 of the European Parliament and of the Council. For pharmaceutical applications Evonik can supply special grades of silica produced according to the guidelines of the International Pharmaceutical Excipients Council (IPEC)-GMP. Pharmaceutical silica grades comply with and are certified according to the most relevant pharmacopoeia monographs EP, USP and/or JP and are regularly tested.

As the regulations significantly differ from country to country, please ask for further details on your application and region. Kosher and Halal certificates are available on request.

5 Description of some selected Evonik Specialty Silica

In the following section a short introduction to some of the most frequently used types of Evonik Specialty Silica is given as a guide for selecting the appropriate grade for certain applications. Please note, for specific applications there might be particular products, which perform even better. Evonik provides service to its customers in order to choose the optimum solution individually.

5.1 SIPERNAT® precipitated silica

Hydrophilic products:

SIPERNAT® 22:
A silica, which combines high absorption capacity with good flowability. It is our basic recommendation as carrier for converting any kind of liquid into a free flowing powders. It can also be used as grinding aid for low melting powders, spices, etc.

SIPERNAT® 22 S:
Due to its high absorption capacity combined with particle fineness this silica is used as flow and anticaking agent in many applications. In plant protection, it is recommended as carrier in solid formulations such as wettable powders (WP), where milling of the final formulation has to be avoided, or in water-dispersible granules (WG).

SIPERNAT® 22 LS:
A very finely ground silica with high absorption capacity for liquids; it reduces caking and improves flowability of fine powders.

SIPERNAT® 33:
Because of its spherical particles, this silica combines low dustiness with very high absorption capacity. This type of silica converts liquids into highly concentrated very well flowing powders with a high bulk density.

SIPERNAT® 50:
This carrier silica with particular high absorbency has the capacity to convert liquids into powders. Concentrates up to 75 % can be produced using this grade. It is also used as grinding aid for hygroscopic products.

SIPERNAT® 50 S:
This silica with particularly high absorption capacity combined with particle fineness enhances flowability and prolongs shelf life of powdered substances which are prone to caking. It also acts as a highly effective carrier in case particle fineness is needed in addition to high concentration.

SIPERNAT® 320:
Silica with a medium particle size and moderate absorption capacity; it offers significant advantages in numerous applications: e. g. as carrier for liquids, flow agent for powders and as grinding aid or carrier in agrochemical formulations.

SIPERNAT® 350:
Its very fine size, proper absorbency and slightly alkaline pH-value yield an interesting combination of physico-chemical characteristics. In plant protection, this fine product is recommended as carrier for acid-sensitive active ingredients. In soft powders it acts effectively as a non-dust-generating flow aid.

SIPERNAT® 360:
This medium sized, highly absorptive silica has a slightly alkaline pH-value and a low surface area. In plant protection, it can be used as carrier for acid-sensitive active ingredients. In soft powders it acts effectively as a non-dust-generating flow aid.

SIPERNAT® 500 LS:
A very finely ground silica with a low drying loss and a particular high absorbence offers advantages to several applications, i. e. as effective flow aid and excellent anticaking agent for fine powders.

SIPERNAT® 2200:
A microgranular silica with spherical particles, low fines content and high absorption capacity. It is able to convert any kind of liquid into nearly dust free powders with high bulk density and very good flow properties.

Hydrophobic products:
SIPERNAT® D 10:
This silica is highly hydrophobic, thus not wettable with water. It is used in a great variety of defoamers due to its high effectiveness in foam destruction. Moisture-sensitive powders benefit from this grade as highly efficient flow and anticaking agent.

SIPERNAT® D 13:
This fine, highly hydrophobic silica grade is also not wettable with water. It is predominantly used in defoamers.

SIPERNAT® D 17:
This fine, hydrophobic silica grade is also not wettable with water. It is particularly suitable as a highly effective anticaking agent for moisture sensitive powders. Examples of applications are fire extinguishing powders, feed premixes or various chemicals, which tend to cake due to moisture.

5.2 AEROSIL® fumed silica

Hydrophilic products:
AEROSIL® 200 (Pharma/F):
Due to the particle structure and very low moisture content, this silica is especially suitable as flow and anticaking aid for very fine powders. An additional advantage is the minimized influence on the appearance and color of the finished powders. Specific grades, which are certified for the pharmaceutical industry (type Pharma) or the food industry (type F), are available.

AEROSIL® 380 (F):
With its fineness, large surface area and low moisture content, this silica grade is an effective flow and anticaking aid for very fine powders, even in case they are hygroscopic or thermoplastic. Specifically for the food industry the type F of this fumed silica is available.

AEROXIDE® Alu C:
A pure aluminium oxide with hydrophilic character, which is especially designed for neutralizing powders which charge electrostatically. It is already effective at very low concentration.

Hydrophobic products:
AEROSIL® R 202:
This highly hydrophobic silica with fine particles, which is not wettable with water, is used as flow- and anticaking aid in fine and hygroscopic powders.

AEROSIL® R 812:
This highly hydrophobic silica with very fine particles, which is not wettable with water, is recommended as flow and anticaking aid in various applications. It is highly effective as it distributes easily in any powder.

AEROSIL® R 972:
Due to its extremely fine particle size and hydrophobic surface this silica can be used to improve flow of moist-sensitive material. It is widely used in the chemical industry and in additives for building materials.

6 Detailed literature on the application of SIPERNAT® and AEROSIL®

TI 1213	"Performance Silica as Flow Agent and Carrier Substance – Recommended Mixing Procedures for Powders and Granulates"
TI 1351	"SIPERNAT® and AEROSIL® as Flow Aid and Anticaking Agent"
TI 1356	"SIPERNAT® and AEROSIL® in Powdered Drinks"
TI 1359	"SIPERNAT® 350 – the low dust anticaking aid"
TI 1386	"AEROSIL® and SIPERNAT® for free flowing and non-caking sugars and sugar alcohols"
II 2124	"SIPERNAT® and AEROSIL® for the Salt Industry"
II 2127	"SIPERNAT® for Animal Feed Industry"
II 2129	"SIPERNAT® and AEROSIL® in the Food industry"
II 2131	"SIPERNAT® and AEROSIL® for Fire Extinguishing Powders"
II 2241	"AEROSIL® and SIPERNAT® Products for Optimized Crop Protection Formulations"
Flyer	"SIPERNAT® and AEROSIL® in Technical Powders"

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