PRODUCT OVERVIEW 106

AEROPERL®

AEROPERL®
Granulated fumed oxides

EVONIK
POWER TO CREATE

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1. Introduction

AEROSIL® fumed silica and AEROXIDE® fumed metal oxides

Evonik proudly looks back on more than 70 years of experience in production, modification, and application of fumed silica. Today we have a broad product portfolio of different fumed silica grades and metal oxides to meet customer expectations and we continuously aim to improve and invent products for and with our customers at numerous sites in Europe, Asia, and North America.

AEROSIL® fumed silica and AEROXIDE® fumed metal oxides are important raw materials for a wide variety of industrial applications. The two brand names represent a group of products designed for high-performance applications. Unlike AEROXIDE® fumed oxide grades, which are essentially crystalline materials, AEROSIL® fumed silica grades are X-ray amorphous. All AEROSIL® and AEROXIDE® products are white, fine, fluffy, and highly pure powders.

To learn more about our AEROSIL® and AEROXIDE® grades please also consult our Technical Overview brochures [1] [2]

Selected AEROSIL® fumed silica grades

AEROSIL® OX 50

Fumed silica with a very low specific surface area (BET), low thickening effect, low agglomeration tendency, and high purity. The product can be used as an additive or as a raw material. In polymer composites, high filler loading can be achieved, making it possible to control essential characteristics of polymers.

AEROSIL® 90, AEROSIL® 130, AEROSIL® 150

Fumed silica grades with low to medium specific surface areas (BET) and therefore excellent reinforcing properties and improved thixotropic effects in applications such as silicone rubber products and sealants.

AEROSIL® 200, AEROSIL® 300

Silica grades with medium to high specific surface areas (BET). Characterized by excellent rheology control of liquid systems, binders, and polymers. Can be used as an anti-settling and thickening agent. Reinforcing agent for silicone rubber products. Improves free flow and anti-caking in powders. Enhanced transparency level for optical applications. Applicable in paints and coatings, polyester resins, adhesives and sealants, gel coats, silicone rubber products, printing inks, food, and cosmetics.

AEROSIL® 380

Silica grade with the highest specific surface area (BET). Excellent rheology control of liquid systems, binders, and polymers. Superior thickening and thixotropic effects. Reinforcing agent for silicone rubber products. Improves free-flow and anti-caking in powders. Enhanced transparency level for aesthetic issues. Applicable in paints and coatings, polyester resins, adhesives and sealants, gel coats, silicone rubber products, printing inks, food, and cosmetics.

AEROSIL® TT 600

Fumed silica characterized by a particularly high degree of agglomeration. The combination of a relatively high specific surface area coupled with the larger aggregate structure produces a unique profile of properties unlike that of any other silica types in the portfolio. The product is recommended, for instance, as an adsorbent, highly transparent matting agent or anti-blocking additive.

Selected AEROXIDE® fumed metal oxide grades

AEROXIDE® TiO_2 P 25

Highly pure titanium dioxide grade with a specific surface area of approx. 50 m^2/g (BET). AEROXIDE® TiO_2 P 25 exhibits heat-stabilizing properties in silicone elastomers. In addition, it can also be used as a catalyst carrier or applied as a catalyst itself or as a photocatalyst in various applications.

AEROXIDE® Alu C

Alumina grade with a specific surface area of approx. 100 m^2/g (BET). Important fields of applications include the lighting industry, where it is used as an additive for homogeneous light emission in fluorescent tubes and light bulbs. It can also be used within polymer coatings such as PET films, where it acts as an anti-blocking agent. Moreover, it is applied in powder coatings as a chargeability-improvement additive or in high-quality paper coatings for high-gloss ink-jet papers.

2. Overview of AEROPERL® granulated fumed oxides

AEROPERL® is the brand name for specially granulated fumed oxides. Evonik offers AEROPERL® granulates made from fumed oxides, such as silica, titania, or alumina. The granulates are largely spherical and combine the excellent characteristics of AEROSIL® and AEROXIDE® with improved handling properties.

The following are the main features and benefits of AEROPERL® products:

- Reduced dust formation
- High tamped density
- Optimized flowability for easier handling and dosing
- Superior absorption capacity
- High degree of porosity (meso- and macropores)
- Defined particle-size distribution

The range of AEROPERL® products is described in more detail in the following list:

AEROPERL® 300/30
Highly porous, hydrophilic fumed silica granulate that can be used as an inert carrier for liquids or as a support for catalytic applications.

AEROPERL® 300 Pharma
Hydrophilic fumed silica granulate. While having the same porosity as AEROPERL® 300/30, this grade fulfills the requirements of the pharmaceutical industry. The material is produced according to IPEC-GMP guidelines and quality tested according to leading pharmacopoeia monographs (EP, USP/NF).

AEROPERL® 3375/20
Granulated fumed silica grade with a small amount of fumed alumina. Its high adsorption capacity and excellent heat stability make it a superior raw material for catalyst supports.

VP AEROPERL® Alu 100/30
Hydrophilic fumed alumina granulate. VP AEROPERL® Alu 100/30 is used for ceramic and paper compositions, for catalyst supports, and in various lighting applications, such as fluorescent tubes or light bulbs.

VP AEROPERL® P 25/20
Hydrophilic fumed titanium dioxide granulate. VP AEROPERL® P 25/20 is used for ceramic compositions, as well as for catalyst supports and photocatalyst applications. Moreover, VP AEROPERL® P 25/20 is ideal for use in heterogeneous catalysis, as its favorable sedimentation properties make it easy to separate from liquid phases. For further information see Technical Information No. 1243 [3]

VP AEROPERL® TiO_2 545
Low-surface-area, granulated fumed metal oxide consisting of titania and a small fraction of silica. It is characterized by a high thermal stability and can be used in catalyst applications.

VP AEROPERL® TiO_2 1580
High-surface-area, granulated fumed metal oxide consisting of titania and a fraction of silica. It is characterized by a high thermal stability and can be used in catalyst applications.

VP AEROPERL® Alu 560
Low-surface-area, granulated fumed alumina grade with a fraction of fumed silica. It is characterized by a high thermal stability and can be used in catalyst applications.

VP AEROPERL® Alu 590
High-surface-area, granulated fumed alumina grade with a fraction of fumed silica. It is characterized by high thermal stability and can be used in catalyst applications.

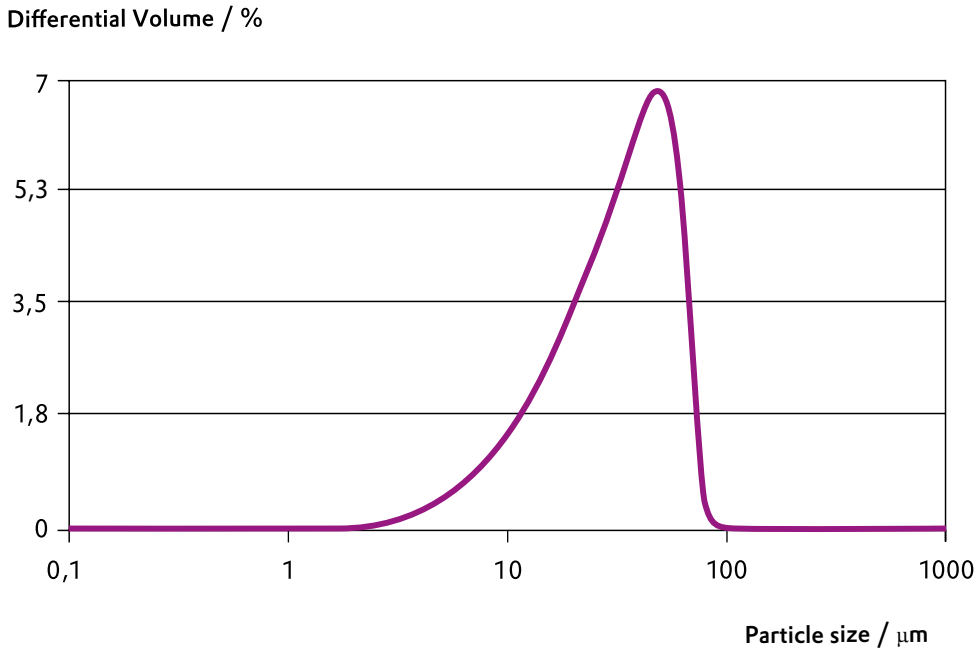
An overview of various physicochemical data on the AEROPERL® products can be found at the end of this brochure. We are happy to answer your questions related to these products and discuss your personal needs for using AEROPERL® granulates in your specific applications.

3. Characteristics of AEROPERL® granulated fumed oxides

3.1 Particle size and shape of AEROPERL® granulated fumed oxides

The production process of AEROPERL® granulates is designed to achieve a defined particle-size distribution. Figure 1 shows an example of the particle distribution of AEROPERL® 300/30, as measured by laser diffraction.

Figure 1
Particle-size distribution of AEROPERL® 300/30, as measured by laser diffraction (BeckmanCoulter). These data are typical values and not part of the specifications.



3.2 Porosity of AEROPERL® products

AEROPERL® granulates are characterized by a high level of porosity. Unlike unmodified, powdery fumed oxides, AEROPERL® products are meso- and macroporous and are therefore ideal for use as carriers to transform liquid or pasty substances into powder form, or as adsorbents for molecules of various shapes and sizes. (See chapter 4.1) Figure 3 shows the rough, porous surface of a silica-based AEROPERL® grade at different magnifications.

Table 1 lists typical data on the pore volume of AEROPERL® grades. The pores are mainly meso- and macropores; the amount of micropores is negligible.

Figure 2:
Scanning electron microscope images of VP AEROPERL® Alu 100/30 on the left, and VP AEROPERL® P 25/20 on the right.

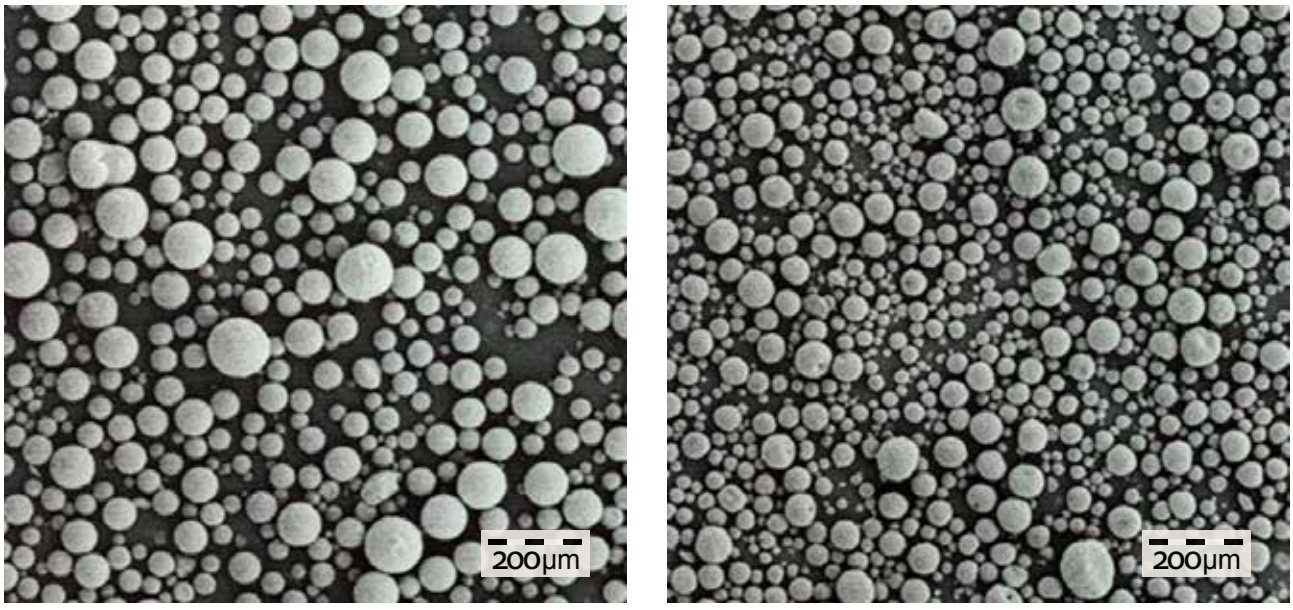
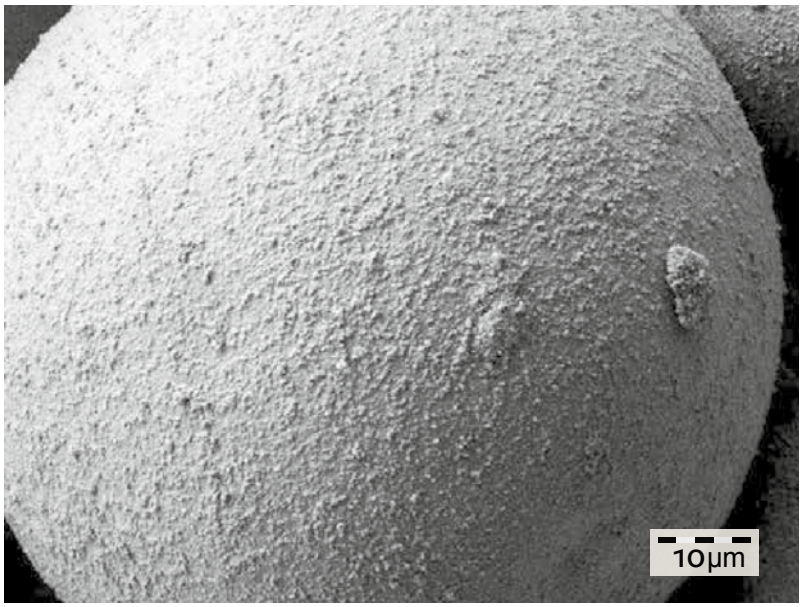


Table 1
Typical data on pore volumes of AEROPERL® granulated fumed oxides. The values given in this table represent typical data and are not part of specifications.

	Mesopores (BJH, 2–50 nm) in cm^3/g	Macropores (Hg-Intrusion, 50 nm – 1 µm) in cm^3/g
AEROPERL® 300/30	ca. 1.8	ca. 0.8
AEROPERL® 300 Pharma	ca. 1.8	ca. 0.8
VP AEROPERL® Alu 100/30	ca. 1.0	ca. 0.3
VP AEROPERL® P 25/20	ca. 0.4	ca. 0.2
AEROPERL® 3375/20	ca. 1.0	ca. 0.1

Figure 3:
Scanning electron microscope images of AEROPERL® 300 Pharma at different magnifications.



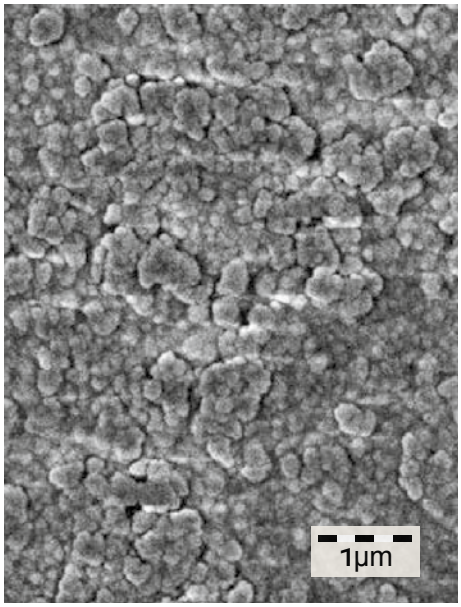


Figure 4:
Flow properties of AEROSIL® 300 (left)
and AEROPERL® 300 Pharma (right)

3.3 Flowability of AEROPERL® granulated fumed oxides

AEROPERL® products show improved flowability and are therefore easier to handle than standard AEROSIL® or AEROXIDE® products. This is due to their unique particle-size distribution and the spherical shape of the AEROPERL® beads. When AEROPERL® grades are used as carriers for liquid substances (see chapter 4.1), the resulting "dry liquid" will exhibit the same excellent flowability as the AEROPERL® product. The improved flow behavior enables reliable dosing and movement through pipelines. Figure 4 is an impressive illustration of the improvement in flowability of AEROPERL® granulated fumed oxides compared to the corresponding AEROSIL® fumed silica and AEROXIDE® fumed oxides. Although the opening of the funnel filled with AEROSIL® 300 (left) is much wider than that of the AEROPERL® 300 Pharma test funnel (right), the material does not flow out.

3.4 Improved tamped density of AEROPERL® granulated fumed oxides for better handling

The difference in tamped densities between an AEROSIL® fumed silica and an AEROPERL® granulate is illustrated in Figure 5. The tamped density of an AEROPERL® granulate is considerably higher than that of corresponding AEROSIL® or AEROXIDE® grade having the same specific surface area (BET).
The same weight of AEROPERL® granulates therefore takes up only about 10–30 % of the space of the corresponding AEROSIL® or AEROXIDE® grade. The improved tamped density results in reduced storage space, easier weighing, less dust, and faster incorporation.

Figure 5:
Difference in tamped densities between AEROPERL® 300 Pharma (left) and AEROSIL® 300 (right) — both cylinders contain the same weight of material.

4. Application examples

4.1 Using AEROPERL® granulated fumed silica as a carrier for liquid substances

Precise dosing of liquid ingredients into a powder blend is often a challenging procedure, especially when these liquids are highly viscous or sticky. Converting these liquids into free-flowing powders by using a carrier silica offers a perfect answer to these challenges. In industry, the absorbates of liquids on a carrier silica often are referred to as "dry liquids." They can be dosed exactly and handled easily without sticking to the equipment. The flow and dust characteristics of the final product are determined by the properties of the carrier silica used. The particle-size distribution of the carrier is the key characteristic to achieve these properties.

A coarser particle size generally corresponds to better flowability and less dust in the resulting product.

AEROPERL® granulated fumed silica combines the chemical purity of fumed silica with a granular structure, which is ideal as a carrier.

Obtaining the optimum performance out of AEROPERL® products as carriers requires the proper mixing technique. Gentle mixing is generally recommended.

The AEROPERL® product should be put into the mixer first, and then the liquid should be added as finely dispersed as possible while the mixer is moving. The best method is to atomize or spray the liquid. Highly viscous liquids or pastes can be heated before addition; this reduces the viscosity and accelerates liquid uptake. In order to keep the porous structure of the AEROPERL® products, we recommend mixing them under low shear forces and keeping the mixing time as short as possible. Excessive shear forces, pressure on the product during mixing, or prolonged mixing time may cause overmixing and will result in the partial destruction of the porous structure and subsequent reduction of the carrying capacity of the liquid.

Recommended mixer types include ploughshare or paddle mixers (see Figure 6 and Figure 7). Some of these mixers are equipped with additional high-shear-intensifier blades to supplement the low-shear, primary mixing tools. These additional high-shear tools should not be used when processing AEROPERL® products. The mixing time in general should not exceed a few minutes. Detailed recommendations on the mixing process can be found in our Technical Information 1213 [4]

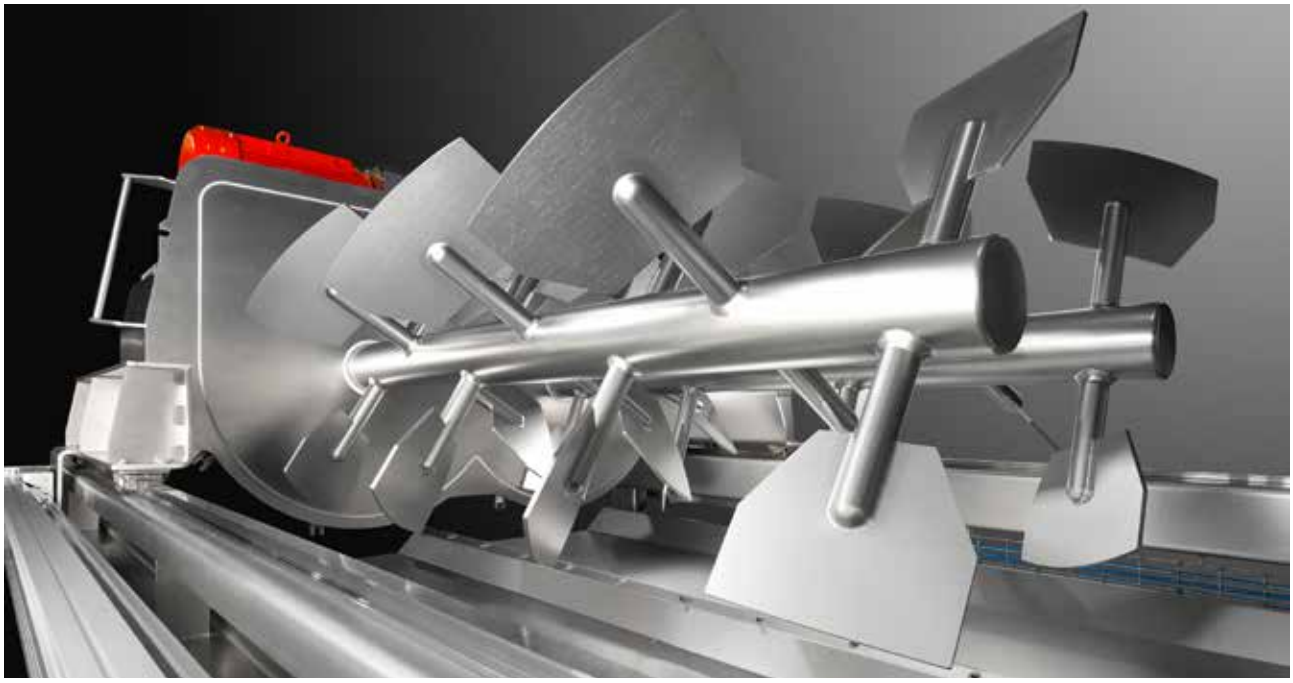


Figure 6:
D-Topline paddle mixer;
© Dinnissen BV, Horsterweg 66,
NL-5975 NB Sevenum

Figure 7:
Ploughshare® mixer; © Gebr. Lödige
Maschinenbau GmbH, Elsenerstr. 7–9,
D-33102 Paderborn, Germany

4.2 AEROPERL® granulated fumed oxides for cosmetic applications

AEROPERL® 300/30 can be used to convert liquids and pastes into free-flowing and easily manageable powders for use in cosmetics. AEROPERL® 300/30 is the carrier of choice for these applications. The total pore volume of this material is excellent for carrier applications.

4.3 AEROPERL® 300 Pharma: a pharmaceutical excipient

AEROPERL® 300 Pharma is a carrier that has been specially adapted to meet the requirements of the pharmaceutical industry. The suffix "Pharma" indicates that production conforms to the guidelines of excipient GMP as defined by the International Pharma Excipient Council (IPEC). Furthermore, the material is tested according to the European (Silica Colloidal Anhydrous) as well as the United States (Colloidal Silicon Dioxide) pharmacopeia monographs.

The most popular pharmaceutical forms today are tablets and filled capsules. Both of these solid dosage forms are manufactured from precursor powders. In order to maximize the output on high-speed machinery while fulfilling regulatory requirements for uniformity of unit weight (and therefore of dosage), it is essential that the precursor powder has excellent flow properties. Liquids and pasty ingredients are often difficult to blend with other powdered ingredients for tablet pressing.

AEROPERL® 300 Pharma granulated colloidal silicon dioxide can be used to convert liquids and pastes into free-flowing and easily manageable powders. More information about AEROPERL® 300 Pharma can be found in our Brochures TI 1414 and TI 1415. [5] [6]

Moisture-assisted dry granulation (MADG) is an innovative new process in pharmaceutical production. This process needs much less moisture than conventional granulation techniques, thus eliminating the need for any drying steps. AEROPERL® 300 Pharma plays an important role in this process, where it adsorbs excess moisture that may still be present after granulation. [7] [8]

4.4 AEROPERL® granulated fumed oxides as catalyst carriers

High-purity silica or metal oxides are often needed for manufacturing catalyst supports. These products may be compacted or granulated to form the final catalyst support. In addition, they can be used as raw materials for the synthesis of catalytically active zeolites, which require highly pure starting materials. In both cases, AEROSIL® fumed silica and AEROXIDE® fumed metal oxides are ideally suited as raw materials. However, handling of these fumed materials is often challenging as they are very low in density and do not flow very well. In zeolite synthesis, AEROSIL® fumed silica grades tend to wet into the reaction slurry slowly and increase the viscosity once mixed. With AEROPERL® granulated fumed oxides, these difficulties are easy to overcome. AEROPERL® products exhibit excellent flowability and are easy to handle and dose. They wet into a slurry more rapidly than standard fumed silica and metal oxides, and do not increase the viscosity significantly. At the same time, they have the same high purity of fumed oxides. For more details please see our Industry Information 2242 [9]

Special AEROPERL® grades derived from mixed oxides are available that show increased heat stability. Details can be found in our catalyst carrier newsletters. [10] [11] [12]

5. Handling, packaging, and storage

AEROPERL® fumed silica granulates are delivered in multi-layer paper bags of various weights, depending on the product and market. For more details on packaging, please consult our Technical Information 1231 [13]. Several options for dust free and automated handling (conveying, dosing, feeding etc.) into both solid and liquid systems are available. Learn more about the handling of silica in our Technical Bulletin Fine Particles No. 28 [14] and please contact a sales agent in your area for detailed information.

Although AEROSIL® fumed silica AEROXIDE® fumed metal oxides and AEROPERL® fumed silica granulates are largely chemically inert and their composition does not change chemically over time, their high specific surface area could result in the adsorption of volatile substances (in the case of moisture, this adsorption is reversible). For this reason, we recommend storing all these products in a dry place, protected from moisture and organic vapors. Detailed information regarding the storage of the aforementioned products can be found in our Technical Information 1373 [15] and the corresponding Product Information. During prolonged periods of storage, AEROSIL® fumed silica AEROXIDE® fumed metal oxides and AEROPERL® fumed silica granulates may become slightly compacted. This can lead to a minor increase in tamped density affecting related product properties. In addition, for safety reasons it should be noted that all dry powders such as AEROSIL® fumed silica and AEROPERL® fumed silica granulates can build up static electrical charges when subjected to friction during conveyance and/or mixing. When handling

AEROPERL® products near flammable or explosive liquids, be sure to take proper safety precautions, such as electrical grounding, etc. Details on electrostatic charging can be found in our Technical Bulletin 62. [16]

Planning dust-free and automated systems requires knowledge of our products and experience in process engineering. As this combination of skills cannot always be provided by the machinery and equipment suppliers, our handling technicians and engineers consult and assist our customers personally — either at the Evonik site in Hanau or, if necessary, on the customer's premises. Where necessary, trials (such as trials for pneumatic dense phase conveying) may also be arranged at external pilot plants (e.g. at the plant manufacturer's factory).

6. Appendix

Product overview of AEROPERL® granulated fumed oxides, including characteristic physicochemical parameters:

Table 2
Characteristic physicochemical data of selected AEROPERL® grades. The values given in this table represent typical data and are not part of the specifications

AEROPERL® grade	Metal oxide type	Specific surface area BET in m^2/g	pH value 4 % dispersion	Loss on drying 2 h at 105 °C in %	Tamped density in g/l
AEROPERL® 300/30	SiO_2	270–330	4.0–6.0	≤ 3.5	ca. 280
AEROPERL® 300 Pharma	SiO_2	260–320	3.5–5.5	≤ 2.5	ca. 280
AEROPERL® 3375/20	SiO_2/Al_2O_3	60–80	3.5–6.5	≤ 2.0	ca. 600
VP AEROPERL® P 25/20	TiO_2	35–65	3.0–4.5	≤ 2.5	ca. 700
VP AEROPERL® TiO_2 545	TiO_2/SiO_2	35–55	3.0–4.5	≤ 2.5	ca. 600
VP AEROPERL® TiO_2 1580	TiO_2/SiO_2	60–90	3.0–4.5	≤ 2.5	ca. 550
VP AEROPERL® Alu 100/30	Al_2O_3	85–115	4.0–6.0	≤ 2.5	ca. 500
VP AEROPERL® Alu 560	Al_2O_3/SiO_2	50–80	4.0–6.0	≤ 2.5	ca. 575
VP AEROPERL® Alu 590	Al_2O_3/SiO_2	70–100	4.0–6.0	≤ 2.5	ca. 500

* tested according to USP/NF & Ph.Eur.

7. References

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