EVONIK INDUSTRIES

Catalyst Carrier

Newsletter

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Introducing AEROPERL® – Granulated Fumed Silica and Metal Oxides from Evonik

AEROPERL® products represent an efficient way of introducing the benefits of fumed silica or fumed metal oxides to your catalyst formulation. And so, in addition to the same high purity of Evonik fumed oxides, AEROPERL® is easier to handle than powder and provides a true pore structure – so important to innovative catalyst design. These special granulates are made from silicon dioxide, aluminum oxide, or titanium dioxide and all are comprised of spherical particles with an average diameter in the range of 20 to 40 µm. Only recently Evonik has added three more AEROPERL® grades to the product portfolio. These grades are based on titania-silica and silica-alumina mixed oxides and show an excellent thermal stability in combination with the handling advantages of a granulated material.

Particle Size and Shape of AEROPERL®

The production process of AEROPERL® is designed to achieve spherical particles with a unique particle size distribution. As an example Figure 1 shows a scanning electron microscope (SEM) image of AEROPERL® Alu 100/30.

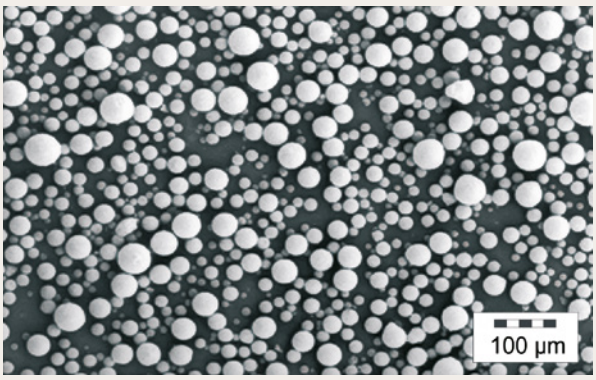


Figure 1
SEM of AEROPERL® Alu 100/30

Porosity of AEROPERL® Granulated Fumed Silica and Metal Oxides

In contrast to fumed oxides, AEROPERL® granulates are characterized by a high level of porosity, dominated by meso- and macropores. Therefore they can ideally be used as carriers and/or absorbents for molecules of various size and shape as well as absorb metal solutions for further treatment and deposition. Figure 2 shows a transmission electron microscope picture of a cross sectional cut through AEROPERL® 300/30, where the porosity can be seen. Table 1 lists typical data on the pore volume of AEROPERL® grades. Remarkable is the extremely low amount of micropores for all AEROPERL® types. AEROPERL® 300/30 exhibits a micropore volume of approximately 0.03 cm^3/g, while all the other AEROPERL® grades show volumes below the detection limit, i.e. < 0.01 cm^3/g.

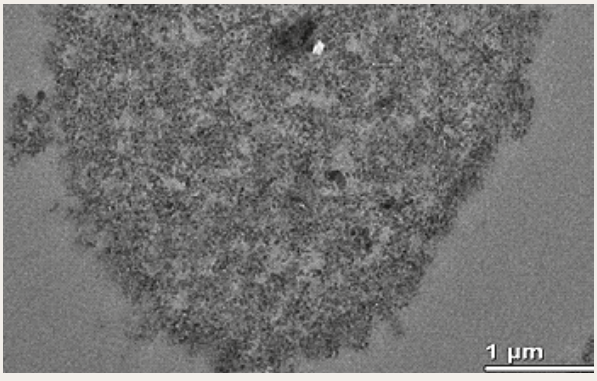


Figure 2
TEM of a cross sectional cut through AEROPERL 300/30

Table 1
Typical data on pore volumes of AEROPERL® granulated fumed oxides.*

AEROPERL® grades	micropores** (< 2 nm) [cm³/g]	mesopores** (2–50 nm) [cm³/g]
AEROPERL® 300/30	0.03	1.83
VP AEROPERL® 50/25	< 0.01	0.12
VP AEROPERL® Alu 100/30	< 0.01	0.98
VP AEROPERL® P25/20	< 0.01	0.44

* approximated values;
** measured by nitrogen adsorption;
The values given in the table represent typical data and are not part of the product specification.

While the pore volume of AEROPERL® lends itself to great utility when preparing metal supported catalytic systems, for greater design of the pore size characteristics we recommend our mesoporous SIPERNAT® grades, as described in the earlier Newsletter #2.

Flowability of AEROPERL® for Better Handling

As mentioned before, AEROPERL® products show an improved flowability and are therefore easier to handle than standard AEROSIL® and AEROXIDE® powders. This, of course, is due to their compact, spherical shape as opposed to the fractal dimensions of typical fumed oxide agglomerates but it is also due to the much higher tamped (or bulk) density for AEROPERL®.

Figure 3 illustrates impressively the improvement in flowability of AEROPERL® versus the related AEROSIL® fumed silica (or AEROXIDE® fumed metal oxide). The excellent flow behavior of AEROPERL® remains even after the material is loaded with liquid (even oily or pasty substances). As seen in the picture, the loaded AEROPERL® (right) flows out of a funnel easily even though the orifice of the funnel is much smaller compared with the funnel on the left side, which is filled with an absorbate based on powdery AEROSIL® 300.

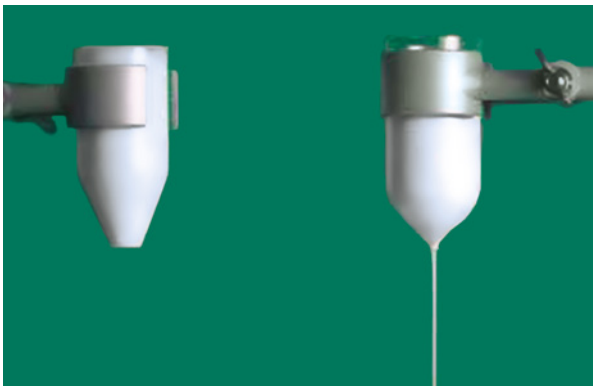


Figure 3
Flowability of silica absorbates loaded with liquid (1:1 by weight).
left: AEROSIL® 300; right: AEROPERL® 300/30.

Corresponding to the improved flowability of AEROPERL® products, there is a striking difference in the tamped (or bulk) density of AEROPERL® vs. AEROSIL® or AEROXIDE® products. The granulate density can be 10-times higher than that of the starting fumed powder. This gives an additional handling advantage compared to the bulky powder materials.

It should be pointed out that this higher flowability and increased bulk density for AEROPERL® granulated fumed oxides do not come at the expense of the other characteristics, which are based on the physical characteristics of the base material, such as purity, specific surface area, or primary particle size. AEROPERL® products combine the benefits of a fumed oxide with the handling properties of spherical granules in an ideal way.

Using AEROPERL® Granulated Fumed Oxides as a Catalyst Support

For the manufacture of catalyst supports, these AEROPERL® products can be used as they are, taking advantage of their convenient pore volume for incipient wetting processes, or they can be used as easily flowable powders for further compaction. In addition, they can be used as raw materials for the synthesis of catalytically active zeolites which require highly pure starting materials with an easy wet-in that does not affect viscosity as significantly as do fumed oxide powders themselves.

Only recently Evonik has added three more grades to the product range of AEROPERL® granulated fumed oxides, which are of particular interest for the catalyst carrier industry. These are AEROPERL® 3375/20, VP AEROPERL® TiO_2 545 and VP AEROPERL® TiO_2 1580.

AEROPERL® 3375/20 is a granulated form of fumed silica doped with small amounts of alumina. This special doping leads to an excellent resistance against sintering at elevated temperature of up to 1200 °C.

VP AEROPERL® TiO_2 545 and VP AEROPERL® TiO_2 1580 are the granulated versions of VP TiO_2 545 S and VP TiO_2 1580 S, which have been introduced in our Newsletter # 1 as new heat resistant fumed titania grades. For both grades the surface area will not collapse during heat exposure and the crystal structure, which is predominantly anatase, will not change into rutile. Thermal and/or hydrothermal aging effects for high surface titania based catalyst supports can be effectively suppressed.

Table 2
Typical data of selected AEROPERL® granulated fumed oxides

Product	specific surface area [m²/g]	pH-value	loss on drying [%]	loss on ignition [%]	tamped density [g/l]
AEROPERL® 300/30	300 ± 30	4.0 – 6.0	≤ 3.5	≤ 2.5	~ 280
VP AEROPERL® 50/25	50 ± 15	4.5 – 6.5	≤ 2.5	≤ 2.5	~ 360
VP AEROPERL® Alu 100/30	100 ± 15	3.6 – 5.6	≤ 2.5	≤ 3.5	~ 500
VP AEROPERL® P 25/20	50 ± 15	3.0 – 4.5	≤ 2.5	≤ 2.0	~ 700
AEROPERL® 3375/20	70 ± 10	3.5 – 6.5	≤ 2.0	≤ 2.0	~ 600
VP AEROPERL® TiO_2 545	45 ± 10	3.0 – 4.5	≤ 2.5	≤ 2.0	~ 600
VP AEROPERL® TiO_2 1580	75 ± 15	3.0 – 4.5	≤ 2.5	≤ 2.0	~ 550

The values given in the table represent typical data and are not part of the product specification

Figure 4
Heat stability of newly developed AEROPERL® granulated fumed oxides in contrast to AEROPERL® P 25/20 – BET surface area after 3 h of exposure to elevated temperatures

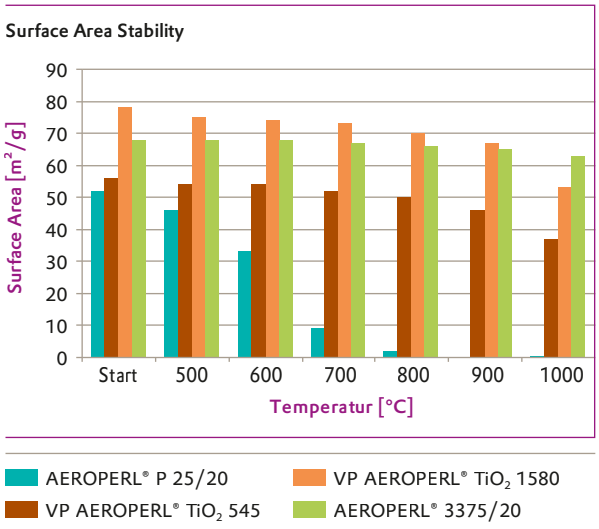
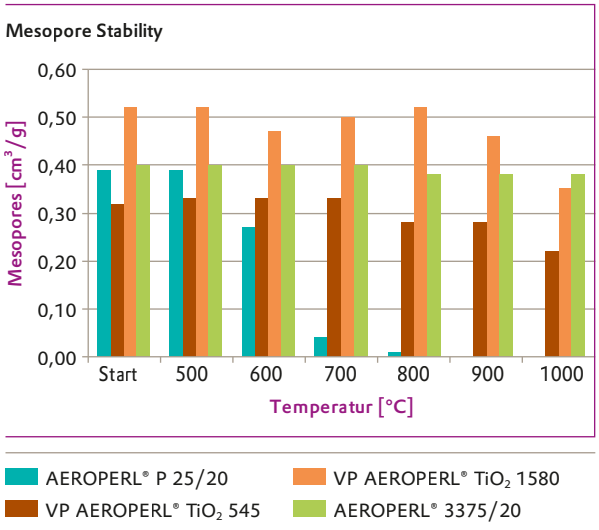


Figure 5
Heat stability of newly developed AEROPERL® granulated fumed oxides in contrast to AEROPERL® P 25/20 – Mesopores, measured by nitrogen adsorption, after 3 h of exposure to elevated temperatures



Summary and Details of AEROPERL® - The Granulated Form of Fumed Silica and Fumed Metal Oxides

The main features of AEROPERL® products are:

- Convenient and defined particle size Distribution
- Excellent sphericity as a particle shape
- High flowability and tamped (or bulk) density
- Optimized flowability for better handling and compaction
- Superior absorption features due to inherent porosity (meso- and macropores)

References

[1] AEROPERL® Granulated Fumed Oxides, Technical Information 1341, Evonik Degussa GmbH
[2] Inorganic Materials for Catalyst Innovation, Industry Information 2242, Evonik Degussa GmbH

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