

DISPERAL DISPAL

High-purity dispersible
alumina hydrates

Sasol Chemicals



SASOL



About us

We at Sasol Chemicals innovate for a better world and deliver long-term value to our customers, communities and society.

Our broad portfolio of high-value products plays an integral role in the creation of numerous solutions that benefit the lives of millions of people.

Thousands of companies around the world leverage our technology, world-class facilities, expertise and collaborative approach to tackle their challenges.



Content

| | |
|---|-----------|
| 1. Alumina production process | 4 |
| 2. DISPERAL/DISPAL | 5 |
| 2.1 High-purity dispersible boehmites | 5 |
| 2.2 Features of sasol dispersible boehmites | 5 |
| 2.3 Advantages of DISPERAL and DISPAL | 6 |
| 2.4 How to disperse and use DISPERAL and DISPAL | 7 |
| 2.5 Water dispersible boehmite | 7 |
| 2.6 Acid dispersible boehmite | 8 |
| 2.7 Neutral to alkaline dispersible boehmites | 8 |
| 2.8 Rheology | 8 |
| 2.9 Solvent dispersible boehmites | 9 |
| 3. Technical data | 10 |
| 3.1 Water dispersible boehmites | 10 |
| 3.2 Acid dispersible boehmites | 10 |
| 3.3 Surface modified boehmites | 10 |
| 4. Product information | 12 |
| 4.1 Storage and transfer | 12 |
| 4.2 Safety and handling | 12 |
| 4.3 Technical support | 12 |
| 5. Certifications | 12 |
| 6. Analytical methods | 14 |
| 6.1 Crystallite size | 14 |
| 6.2 Dispersed particle size | 14 |
| 6.3 Dispersibility of boehmite powder | 14 |
| 6.4 Surface area | 14 |
| 6.5 Trace element analysis | 14 |
| 6.6 Pore volume and pore size distribution | 14 |

1. Alumina production process

Sasol Inorganics produces high- and ultra high-purity aluminas primarily through synthetic aluminum alkoxide processing routes. The alumina is produced either as co-product with synthetic linear alcohols (Ziegler method) or directly from aluminum metal (on-purpose route).

Several production steps must be completed to produce the different alumina-based products. In the first step, an aqueous intermediate (alumina slurry) is produced, which is further tailored in the subsequent processing steps to obtain the various products sold on the market. These can be alumina hydrates, calcined aluminas and doped versions thereof.

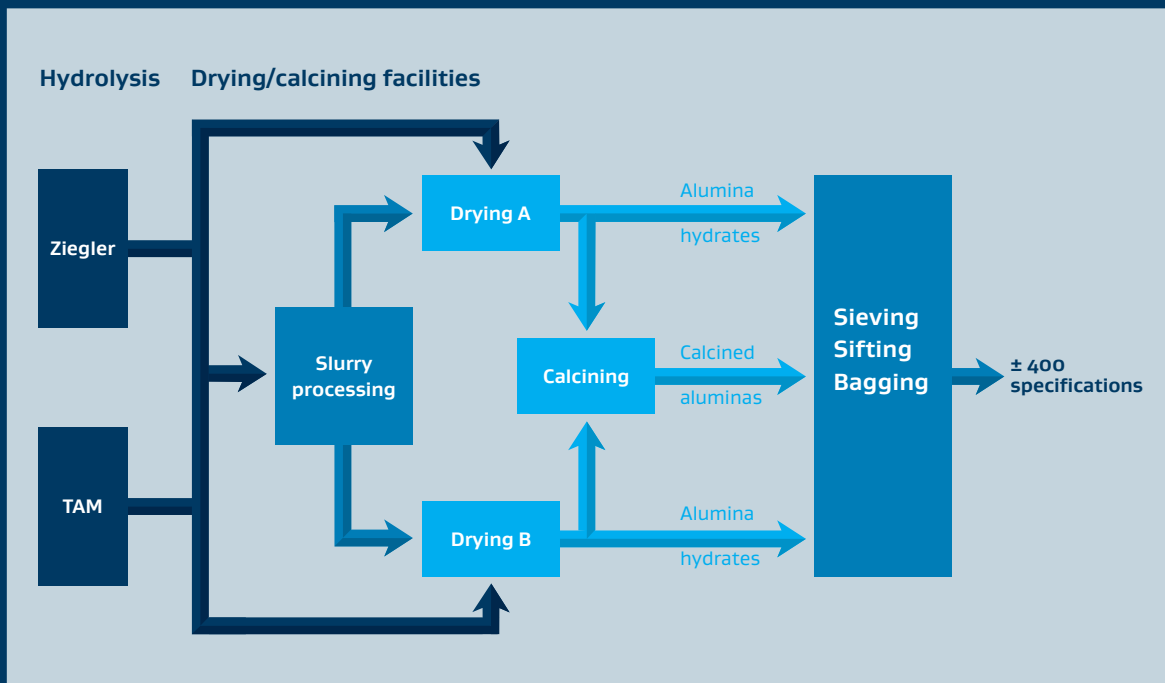


Figure 1: Schematic for the alumina manufacturing process

2. DISPERAL/DISPAL

2.1 High-purity dispersible boehmites

DISPERAL and **DISPAL** are the trademarks for the high-purity, highly dispersible boehmite powders and sols/dispersions manufactured by Sasol in Brunsbüttel, Germany, and in Lake Charles, Louisiana, USA. These boehmites, which are nano-sized in the dispersed phase, exhibit a unique combination of purity, consistency and dispersibility that make them excellent materials for use in colloidal applications. The Sasol range of dispersible boehmites has traditionally been used in applications such as sol-gel ceramics, catalysis, refractory materials, rheology control and surface frictionizing.

Other applications include surface coating as well as paint detackification, polymer-additives and functional fillers.

2.2 Features of Sasol dispersible boehmites

The unique product characteristics of Sasol dispersible boehmites can lead to many advantages for use in different systems. Some key features are:

- The high purity boehmites are produced under careful control to yield products with consistent quality and reliable performance.
- The powders are highly dispersible. Low-viscosity nano-sized particle sols can be prepared at room temperature in 10 to 30 minutes with concentrations of 10 – 40 wt.% AlOOH.
- The boehmites are versatile. They can be employed under a variety of application conditions, including low or high pH and low or high shear.
- Sasol also offers boehmites which are dispersible in polar and non-polar organic media.

Figure 2:
Translucent to opaque boehmite sols,
each with a concentration of
10 wt.% AlOOH



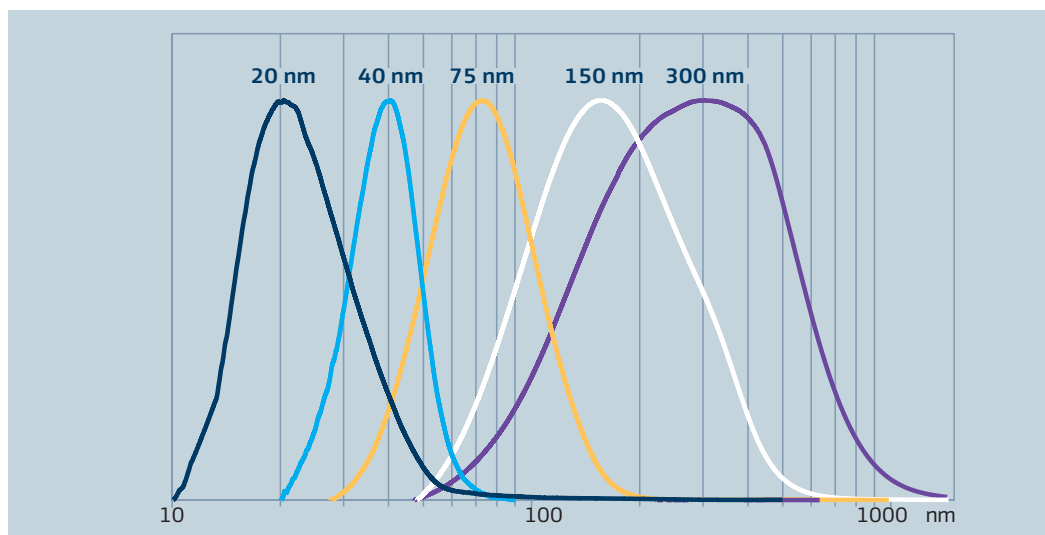
2.3 Advantages of DISPERAL and DISPAL

Sasol pioneered processes utilizing alkoxide chemistry to convert primary aluminium metal into synthetic boehmite of exceptional purity. Unlike other alumina manufacturing processes that start with less pure materials, Sasol's processes yield aluminas with significantly lower levels of common impurities such as iron, sodium and silica (Table 1). Additionally, our 50 years of experience, in combination with other proprietary production techniques, allow us to produce highly dispersible boehmites with a wide range of physical properties such as dispersed particle size (Figure 3) resulting in translucent to opaque dispersions (Figure 2). Thus, our customers are not limited in their thinking for possible uses for the aluminas.

Table 1:

| Chemical purity of DISPERAL and DISPAL boehmite powders | |
|---|---------------|
| Impurity | ppm (typical) |
| Na ₂ O | <20 |
| Fe ₂ O ₃ | 50 – 100 |
| SiO ₂ | 50 – 120 |

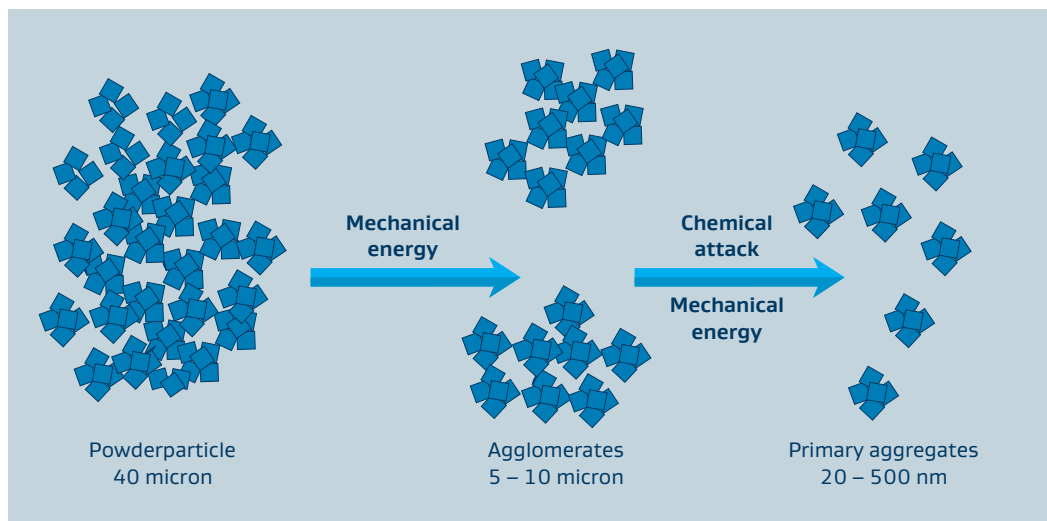
Figure 3:
Dispersed particle size distributions
of selected products



2.4 How to disperse and use DISPERAL and DISPAL

DISPERAL and **DISPAL** powders may be dispersed by following the descriptions below. Figure 4 shows a schematic representation of what occurs to the powder during dispersion using chemical attack and mechanical energy.

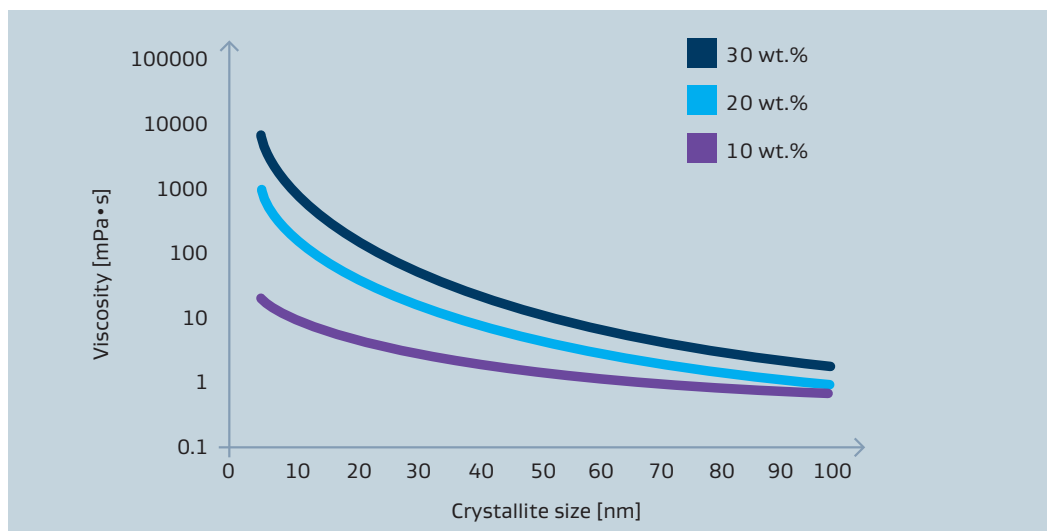
Figure 4:
Schematic mechanism of dispersion



2.5 Water dispersible boehmites

To form a colloidal sol or dispersion from a water dispersible **DISPERAL** or **DISPAL** powder (see page 10), simply stir the powder in deionized water with moderate to intense agitation at room temperature for 20 – 30 minutes. The maximum achievable solids loading will vary according to the specific boehmite selected (Figure 5). For most applications, the boehmites perform best when completely dispersed prior to further formulation. The resulting pH will be between 3 and 5. **DISPAL 11N7-80** that is modified with 0.1 wt.% nitric acid can be dispersed at pH 6 – 7 as well.

Figure 5:
Schematic mechanism of dispersion



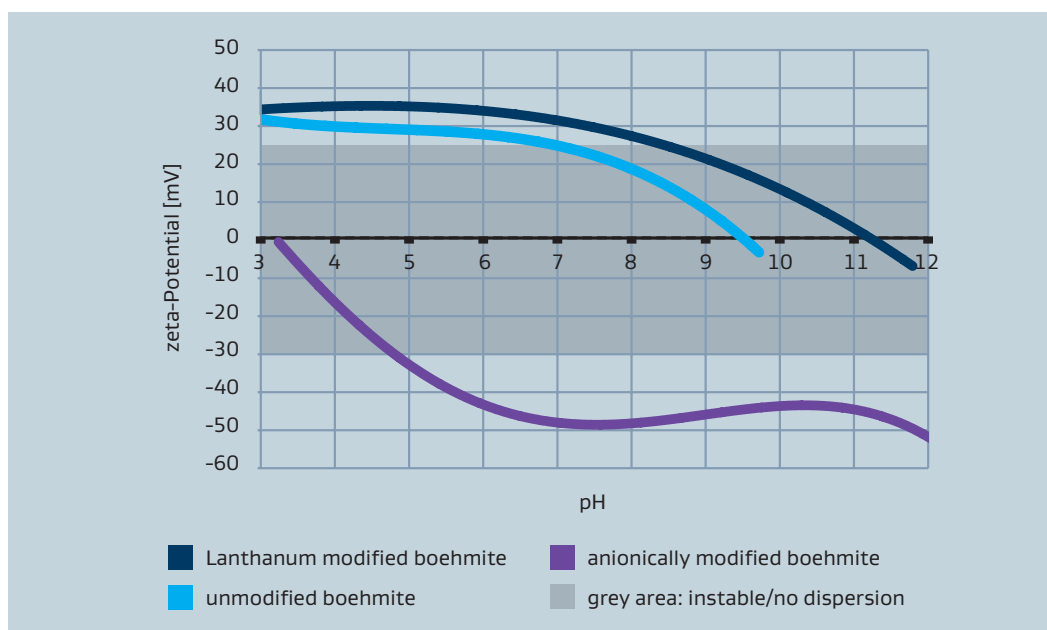
2.6 Acid dispersible boehmites

Dispersions of acid dispersible products may be formed in a similar fashion described above by dispersing in dilute aqueous monovalent acids such as nitric, hydrochloric, formic or acetic (typically < 1 wt.% acid) at pH 3 – 5.

2.7 Neutral to alkaline dispersible boehmites

By changing the surface chemistry Sasol boehmites can also be stabilized under neutral and alkaline conditions. By modification with lanthanum the isoelectric point can be shifted to higher pH values, providing stability at pH 6 – 7. DISPERAL HP14/7, DISPAL 23C9 and DISPAL 18C9 are surface modified with citric acid to provide colloidal stability at pH 8 – 10. The stability of the dispersion is dependent on the absolute value of the zeta potential (Figure 6).

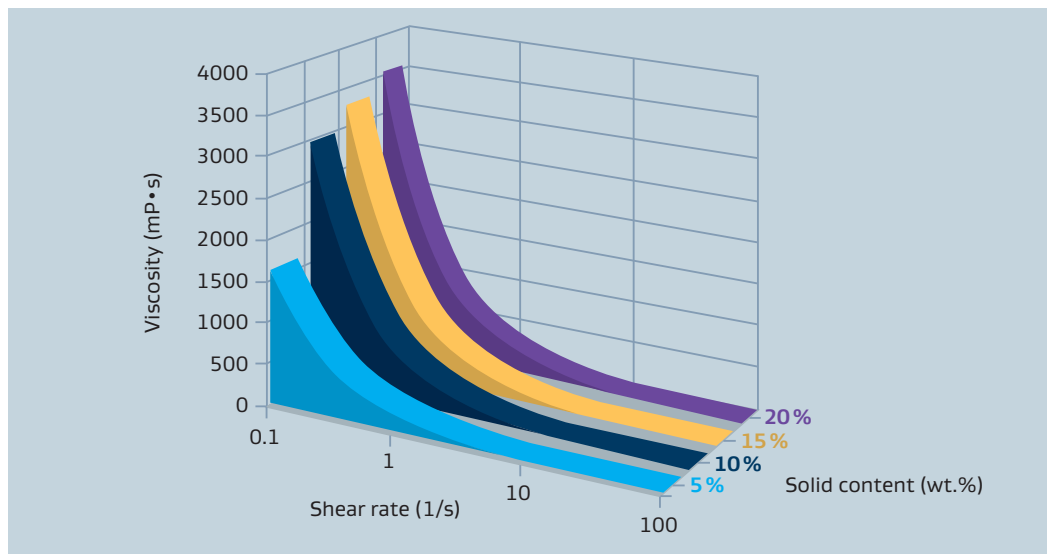
Figure 6:
Zeta potential curves of some boehmites



2.8 Rheology

Rheological characteristics of boehmite dispersions can be affected by numerous factors. These include product used, solid content, crystallinity, water quality, pH, ionic strength and other formulation components. Figure 5 gives example curves of viscosity versus crystallite size for some typical Sasol products. Also low-viscosity dispersions can be “thickened” by the addition of acids, bases or salts to form thixotropic, shear-thinning systems (Figure 7). This, for example, allows boehmite to function as a thickener for many types of either acidic or basic formulations.

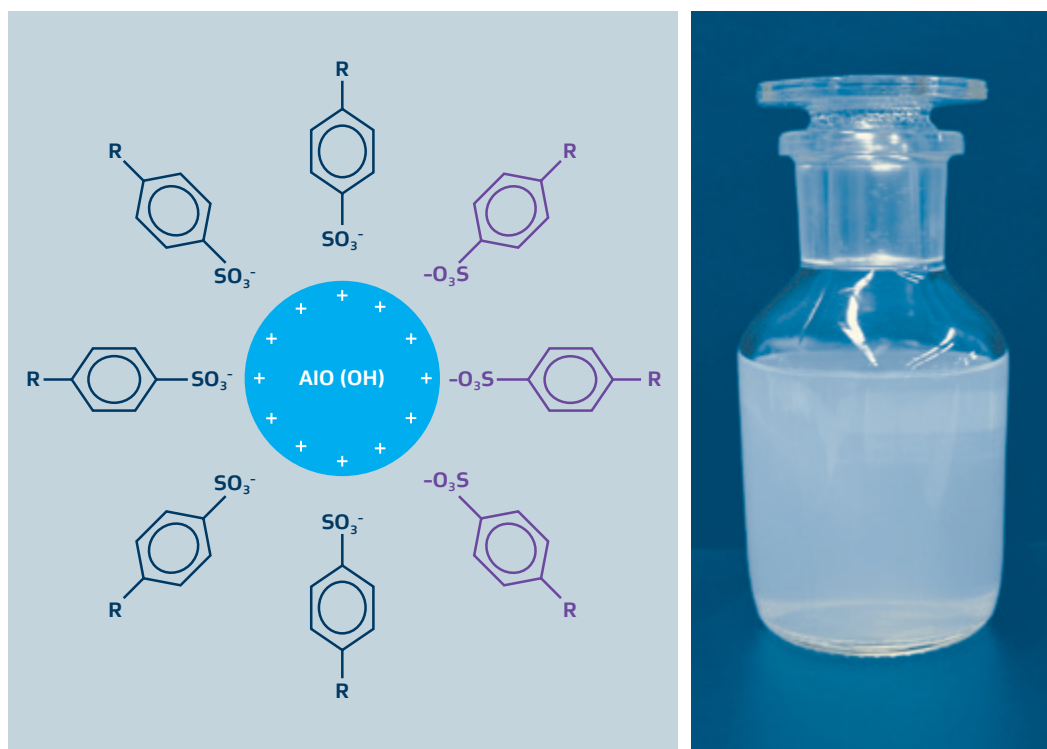
Figure 7:
Effect of boehmite concentration on
viscosity versus shear rate



2.9 Solvent dispersible boehmites

Sasol dispersible boehmites may be dispersed in organic solvents. Stable dispersions can be prepared by dispersing the non-modified boehmite powder under intense mixing into the solvent in presence of a stabilizing agent. For further, detailed information please contact one of our representatives. Another option is the use of already surface-treated boehmites that do not need further stabilization (Figure 8). Different grades are available for organic solvents.

Figure 8:
Schematic for a surface modified
boehmite and dispersion in ethanol
(solid content 10 wt.%)



3. Technical data

3.1 Water dispersible boehmites

| Typical chemical and physical properties | | DISPERAL P2 | DISPAL T25N4 | DISPAL 25F4 | DISPAL 23N4-80 | DISPAL 18N4-80 | DISPAL 14N4-80 | DISPAL 11N7-80 | DISPAL 10F4 | DISPAL 8F4 |
|---|---------------------|-------------|--------------|-------------|----------------|----------------|----------------|----------------|-------------|------------|
| Solid content (Al ₂ O ₃) | [%] | 72 | 78 | 78 | 80 | 80 | 80 | 80 | 83 | 83 |
| Nitrate | [%] | 4.0 | 4.5 | – | 1.6 | 1.1 | 0.7 | 0.1 | – | – |
| Formate | [%] | – | – | 2.0 | – | – | – | – | 0.25 | 0.2 |
| Loose bulk density | [g/l] | 850–1000 | 800 | 820 | 980 | 870 | 850 | 620 | 550 | 500 |
| Particle size (d ₅₀) | [µm] | 45 | 30 | 30 | 50 | 50 | 50 | 40 | 30 | 30 |
| Surface area (BET)** | [m ² /g] | 260 | >230 | 250 | 200 | 180 | 140 | 100 | 100 | 95 |
| Pore volume** | [ml/g] | 0.5 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.8 | 0.8 | 0.7 |
| Crystallite size (021) | [nm] | 4.5 | 7.0 | 8 | 9 | 15 | 18 | 30 | 40 | 53 |
| Dispersed particle size*** | [nm] | 20 | 50 | 70 | 90 | 110 | 120 | 220 | 240 | 350 |

Dispersions of water dispersible products may be formed by simply stirring the powder in deionized water.

3.2 Acid dispersible boehmites

| Typical chemical and physical properties | | DISPERAL | DISPERAL 20 | DISPERAL 40 | DISPERAL 60 | DISPERAL 80 | DISPERAL HP 14 | DISPERAL HP 18 | DISPAL 18HP | DISPAL 25 |
|---|---------------------|----------|-------------|-------------|-------------|-------------|----------------|----------------|-------------|-----------|
| Solid content (Al ₂ O ₃) | [%] | 77 | 77 | 80 | 80 | 95 | 77 | 77 | 77 | 70 |
| Loose bulk density | [g/l] | 400–600 | 500–700 | 400–600 | 300–500 | 200–500 | 300–500 | 300–500 | 300–500 | 650–850 |
| Particle size (d ₅₀) | [µm] | 15 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 30 |
| Surface area (BET)** | [m ² /g] | 180 | 150 | 100 | 100 | 80 | 160 | 150 | 150 | 200 |
| Pore volume** | [ml/g] | 0.5 | 0.7 | 0.8 | 0.9 | 0.9 | 1.1 | 1.2 | 1.2 | 0.4–0.6 |
| Crystallite size (021) | [nm] | 10 | 20 | 40 | 50 | 65 | 14 | 18 | 18 | 4–5 |
| Dispersed particle size*** | | | | | | | | | | |
| Measured with PCS | [nm] | 80 | 150 | 250 | 350 | 500 | 100 | 150 | 200 | 60 |
| Measured with disc centrifuge | [nm] | 40 | 100 | 180 | 250 | 300 | 80 | 100 | – | – |

3.3 Surface modified boehmites

| Typical chemical and physical properties | | DISPERAL HP 14 L1 | DISPERAL HP 14/7 | DISPAL 18C9 | DISPAL 25SR | DISPAL 23C9-80 |
|---|---------------------|-------------------|------------------|-------------|-------------------------|----------------|
| Solid content (Al ₂ O ₃) | [%] | 75 | 70 | | 65 | 70 |
| Surface treatment | | La-acetate | Citric acid | | p-toluene sulfonic acid | Citric acid |
| Loose bulk density | [g/l] | 300–500 | 300–500 | | 400–600 | 750 |
| Particle size (d ₅₀) | [µm] | 35 | 35 | | 35 | 50 |
| Surface area (BET)** | [m ² /g] | 150 | 150 | | 240 | 170–250 |
| Pore volume** | [ml/g] | 1.0 | 1.0 | 0.4–0.7 | 0.5 | 0.4–0.7 |
| Crystallite size (021) | [nm] | 14 | 14 | | 10 | 8–12 |
| Stability | [pH] | 3–6 | 8–10 | | – | 8–10 |

Chemical purity: C: 0.25 %, SiO₂: 0.01–0.015 %, Fe₂O₃: 0.005–0.015 %, TiO₂: 0.01–0.15 %

* Particle size as measured on the powder

** Activation at 550 °C for 3 hours

*** 10 wt.% Al₂O₃ in 0.4 wt.% HNO₃

Further specialty grades are available upon request.
Analytical methods see page 14.

Dispersions of acid dispersible products may be formed by dispersing in dilute aqueous monovalent acids (typically 1 wt.% acid) such as nitric, hydrochloric, formic, lactic or acetic acid.



4. Product information

4.1 Storage and transfer

DISPERAL and **DISPAL** boehmite powders are mildly abrasive materials having a Mohs hardness of 3.5 to 4.0. Therefore, handling and storage equipment should be designed for such materials. Examples are aluminium, abrasion resistant carbon steel and polypropylene or epoxy-lined steel. Blower or vacuum systems can be used to move the powders.

A minimum of 4,000 ft/min fluidizing velocity is recommended. Boehmite powders will absorb atmospheric moisture and facilities should be designed appropriately. The liquids are readily pumpable using standard centrifugal or positive displacement pumps. Due to the pH range of available products, recommended materials for process equipment include stainless steel, or polymeric-lined steel.

4.2 Safety and handling

DISPERAL and **DISPAL** boehmite powders are classified as non-toxic nuisance dusts.

Exposure to high concentrations of dust may cause physical irritation and drying of skin and eye tissues. Repeated or prolonged contact with alumina sols may cause irritation as well. Handling and shipping procedures should be designed to avoid such contact and to minimize the inhalation of airborne dust. Normal good laboratory practices and operating procedures should ensure personnel safety. See also corresponding material data safety sheet.

4.3 Technical support

The Sasol alumina organization is committed to offering the technical service necessary to ensure customer satisfaction. Technical support is available worldwide to aid you in choosing the best alumina for your needs, as well as for providing advice on safe and efficient use. The products described in this brochure give some indications of our total capability. We look forward to discussing specific technical requirements with you.

5. Certifications

All Sasol Chemicals locations worldwide are certified to DIN ISO 9001/14001 and to OHSAS 18001 standards (Occupational, Health and Safety Assessment Series), and the German plants additionally comply with EMAS III (Eco Management and Audit Scheme).

Our production sites operate according to an internationally recognised, integrated quality, environmental and safety management system that has been established at the sites for many years.



6. Analytical methods

6.1 Identification of crystalline phases and average crystal size

Powdered samples of the boehmite are analyzed by using X-Ray Diffractometry (XRD) on either a Siemens D5000 or a Philips X'Pert diffractometer. The resulting powder patterns allow for identification of the crystalline compounds of the materials.

6.2 Dispersed particle size

The particle size distribution of diluted boehmite sols and dispersions is measured using laser diffraction or photon correlation spectroscopy techniques on Malvern, Horiba or Cilas instruments. Alternatively dispersed particle sizes can be measured using a disk centrifuge supplied by CPS.

6.3 Dispersibility of boehmite powder

A specified amount is added to water or dilute acid under stirring. The mixture is then stirred for a specified period of time to form a dispersion. The dispersion is centrifuged, and the undispersed residue is isolated, dried and weighed to determine the percentage of non-dispersed material.

6.4 Surface area analysis*

Alumina surface area is then measured using BET nitrogen adsorption techniques on instruments supplied by Quantachrome (Nova series) or by Micromeritics (Gemini series).

6.5 Trace element analysis

Trace element analysis is performed by using several methods, including X-ray fluorescence of pressed alumina disks and wet techniques (ICP/OES).

6.6 Pore volume and pore size distribution*

The boehmite is first calcined at 550°C for three hours in preparation for analysis. The porosity is measured by nitrogen adsorption and desorption using Autosorb instruments supplied by Quantachrome.

* after thermal treatment at 550°C for three hours



At your service



Sasol Chemicals
Advanced Materials

Sasol Germany GmbH
inorganics@de.sasol.com
www.sasolgermany.de

Sasol Chemicals North America LLC
inorganics@us.sasol.com
www.sasolnorthamerica.com

Sasol Chemicals Japan KK
inorganics@jp.sasol.com

www.sasolalumina.com

www.sasol.com

Source reference:

Cover: Sasol Germany GmbH, p. 3: Sasol Ltd., p. 5 - 9, p. 11, p. 13, p. 15: Sasol Germany GmbH

Sasol is a registered trademark of Sasol Ltd. Product trademarks displayed in this document are the property of the Sasol Group of companies, except where it is clear from the context that not. Users of this document are not permitted to use these trademarks without the prior written consent of their proprietor. All rights not expressly granted are reserved. Reference to trademarks used by other companies is neither a recommendation, nor should it give the impression that products of other companies cannot be used.

Disclaimer: The information contained in this document is based on Sasol's knowledge and experience at the time of its creation. We reserve the right to make any changes to this document or the products described therein, as a result of technological progress or developments. This information implies no liability or other legal responsibility on our part, including with regard to existing third-party patent rights. In particular, no guarantee or warranty of properties in the legal sense is implied. The customer is not exempted from the obligation to conduct careful inspection and testing of incoming products. All our business transactions are governed exclusively by our General Business Terms.