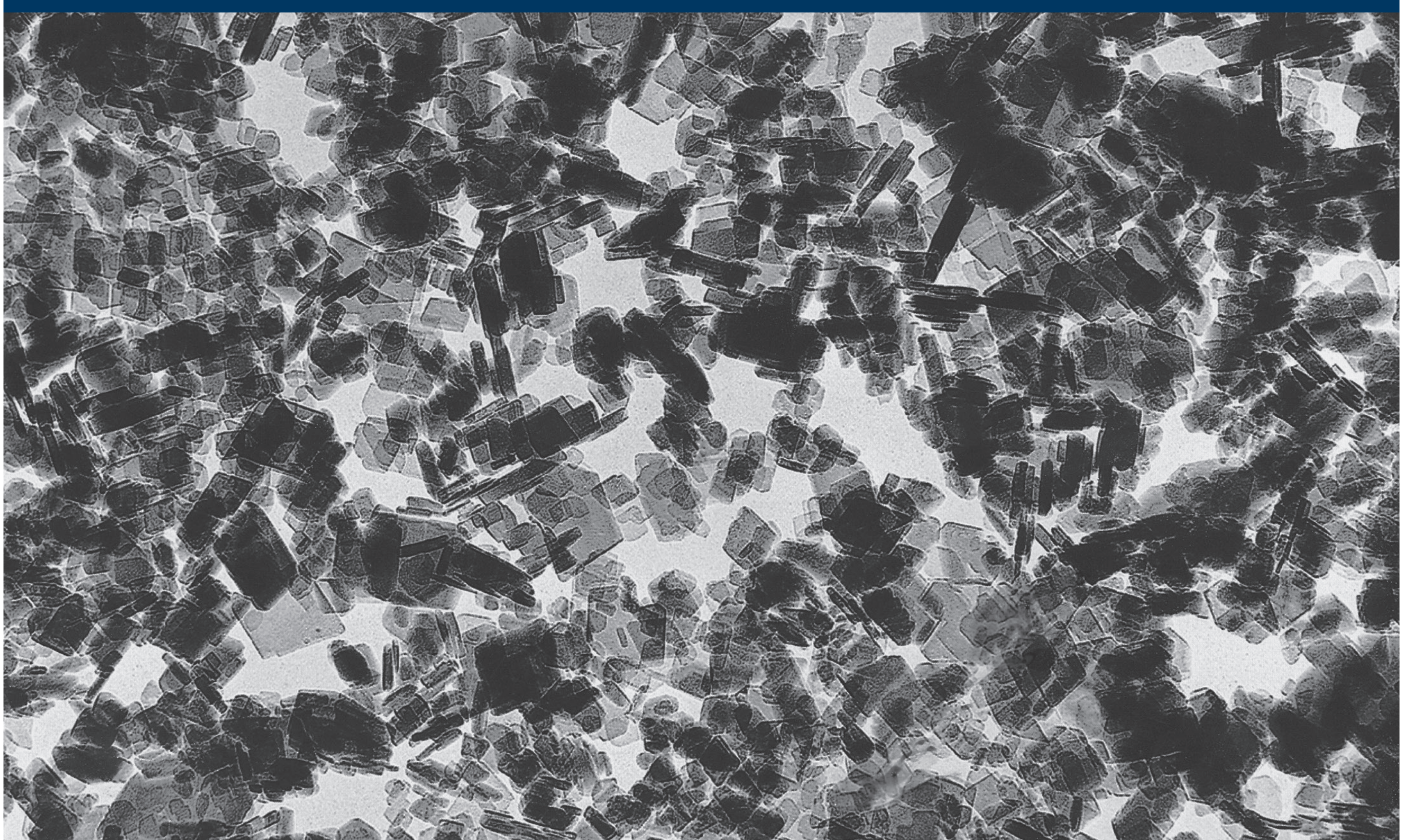
PURAL
CATAPAL
High-purity alumina hydrates

Sasol Chemicals



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

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.

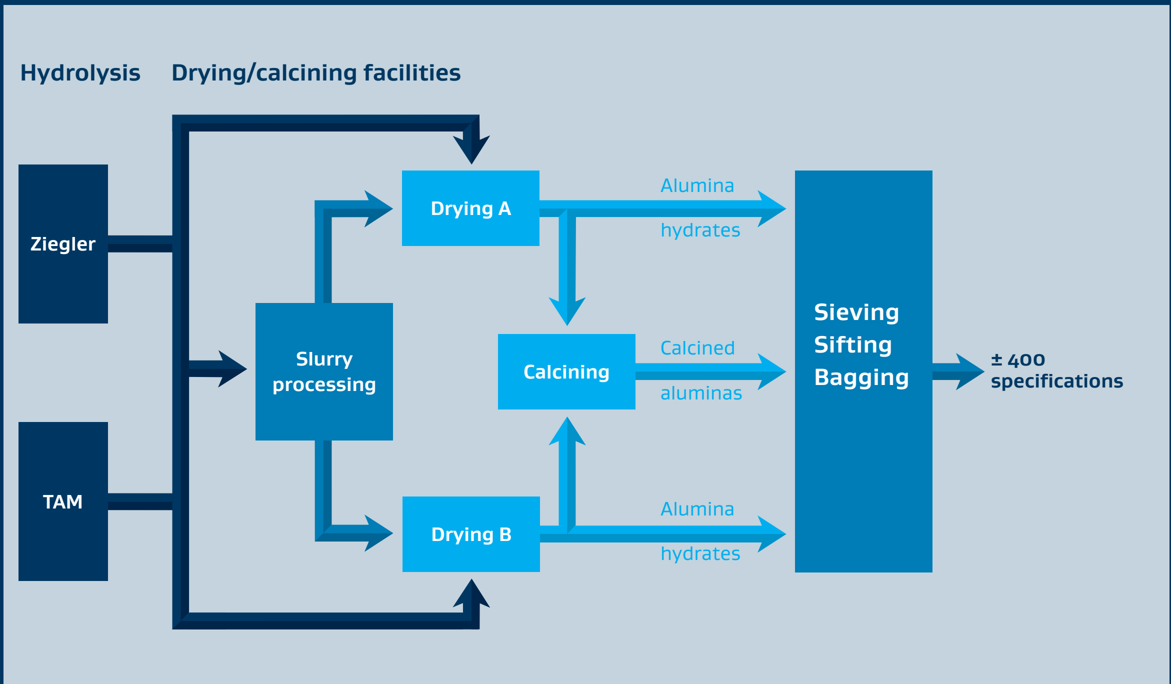


Figure 1: Schematic for the alumina manufacturing process

2. PURAL/CATAPAL

2.1 High-purity alumina hydrates

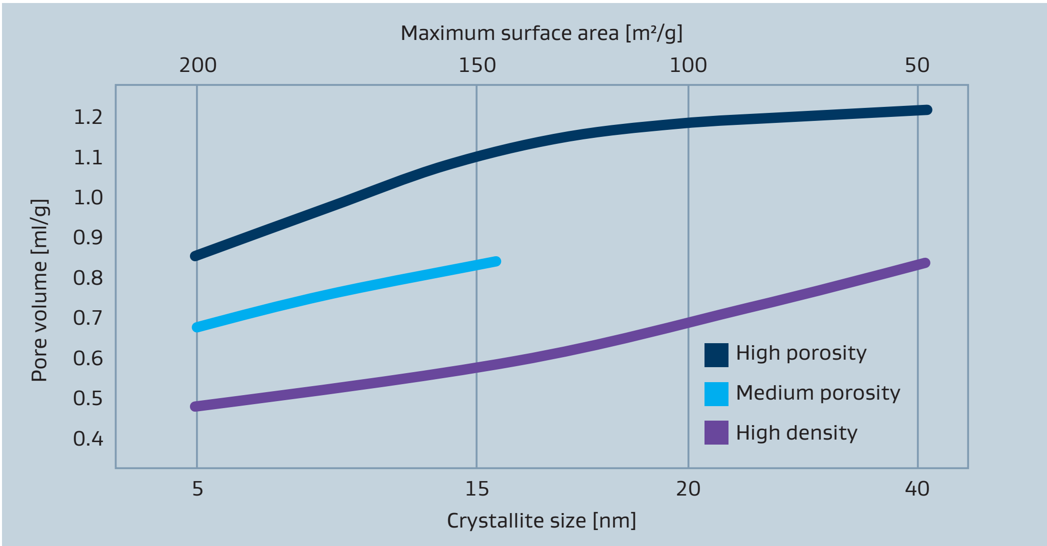
PURAL and **CATAPAL** are the respective tradenames for the High-purity alumina hydrates manufactured in Brunsbüttel, Germany, and Lake Charles, Louisiana, USA. **PURAL** and **CATAPAL** are available as white, free-flowing powders whose unique combination of purity and controllable physical properties make them excellent starting materials for many products. This family of alumina hydrates (boehmite, AlOOH, and bayerite, $Al(OH)_3$) has historically been chosen as supports or binders for catalysts in refinery and chemical processes. Recent developments in many other applications have demonstrated these unique aluminas have applications in areas far beyond catalysts.

2.2 Advantages of PURAL and CATAPAL alumina hydrates

Sasol pioneered processes to convert aluminium metal to synthetic alumina hydrates of high-purity (figure 1). Unlike other alumina manufacturing processes that start with bauxite derivatives, our processes yield aluminas with significantly lower levels of common impurities such as iron, sodium and silica (as shown in table 1). Additionally, our 50 years of alumina manufacturing experience allows us to control and adjust physical properties such as surface area and porosity (figure 2), particle size (figure 3), crystal size and shape (figure 4) and peptization behavior (figure 5) so that our customers are not limited in their thinking for possible uses for the aluminas.

Ultra-high-purity grades **(PURAL UHPA)**, impurities shown in table 2 are available upon request.

Figure 2: Relationship between crystallite size, pore volume



Chemical purity of PURAL and CATAPAL alumina hydrates

Impurity	ppm (typical)
Na_2O	<20
Fe_2O_3	50–100
SiO_2	50–120

Table 1

Purity of PURAL UHPA alumina hydrates

Impurity	ppm (typical)
Na_2O	1
Fe_2O_3	3
SiO_2	3

Table 2

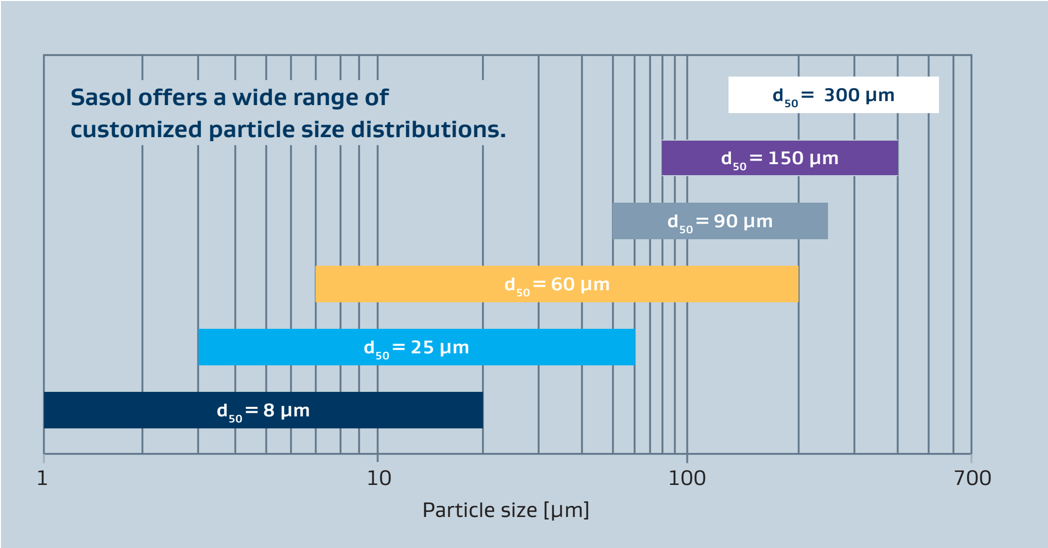


Figure 3:
Examples of particle size distributions of PURAL and CATAPAL

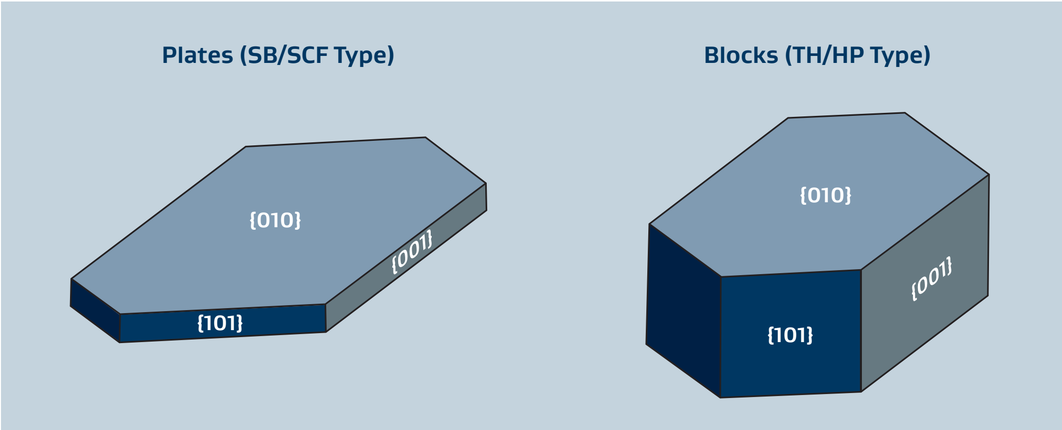


Figure 4:
Boehmite of different crystal shapes

Modelling:
Momma, K.; Izumi,
F.J. Appl Crystallogr.
2011, 44, 1272–1276.

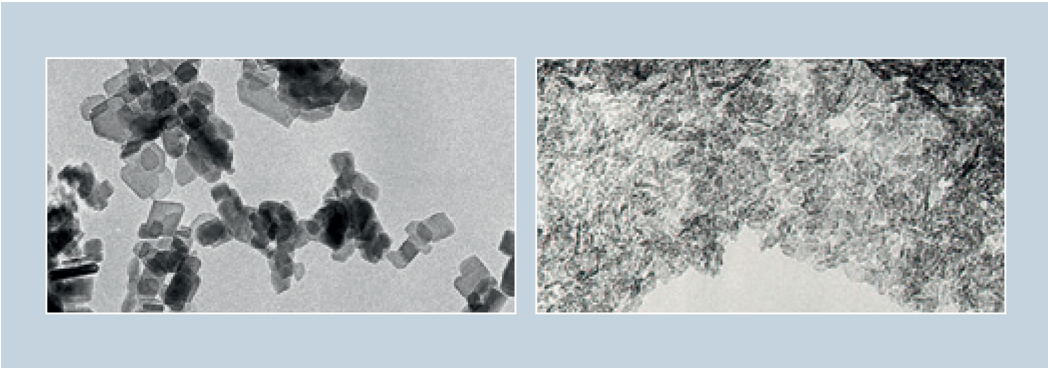


Figure 5:
TEM images of boehmite with different crystallite sizes

2.3 Processing of PURAL and CATAPAL

The unique ability to adjust the physical properties of the boehmites makes them perfect for a variety of different end use applications requiring different types of processing.

2.4 Extrusion behavior

Extrusion is a key use for these types of alumina hydrates due to their ability to form excellent extruded supports. This application takes advantage of the ability to peptize in the presence of organic/inorganic acids.

A wide variety of extrudate properties can be obtained by using different grades of **PURAL** and **CATAPAL** and by controlling the formulation and extrusion variables. Optimum formulations depend on the exact choice of mixer, extruder and powder properties. General extrusion guidelines can be recommended by our technical staff.

Our unique ability to adjust the peptization behavior means that the gelling behavior of **PURAL** and **CATAPAL** can be modified to supply a product optimized for our customers' own unique set of processing conditions. Nitric acid gelation time (NAG) is a valuable tool for selecting the right material for your processing conditions.

NAG is the time required for a concentrated dispersion of boehmite to reach a certain viscosity by peptization. This behavior is shown in figure 6 and illustrates the range of NAGs we are able to produce on our customers' request. The graph is not meant to indicate the only NAGs available.

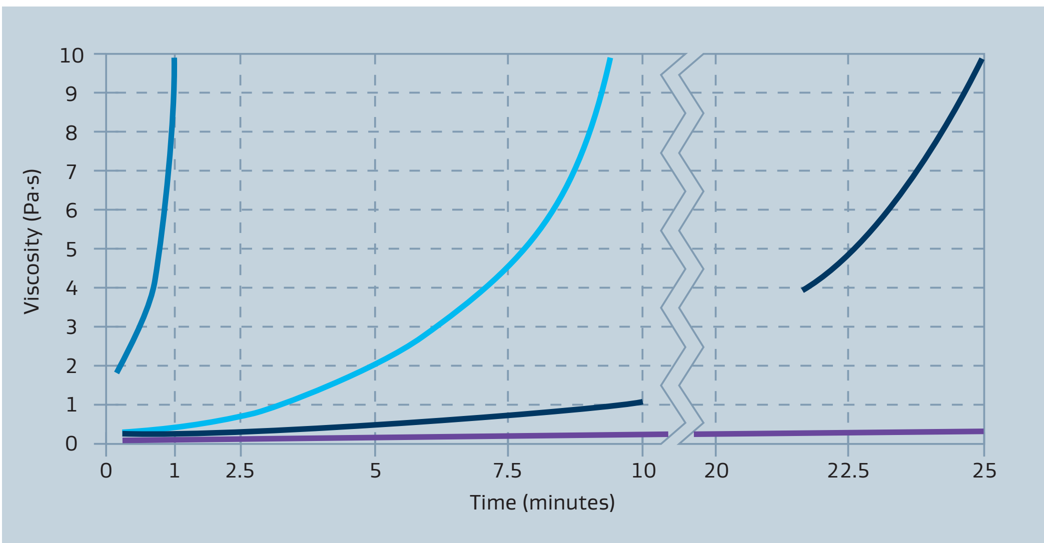


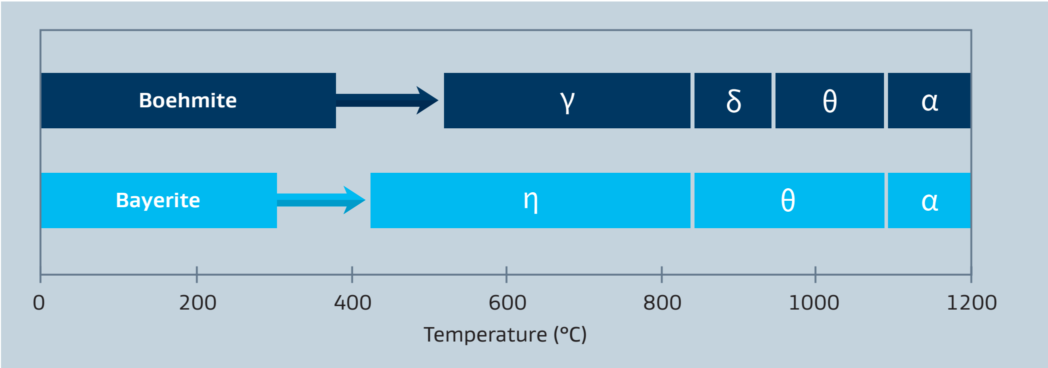
Figure 6: Viscosity behavior of boehmite dispersions having different NAG values

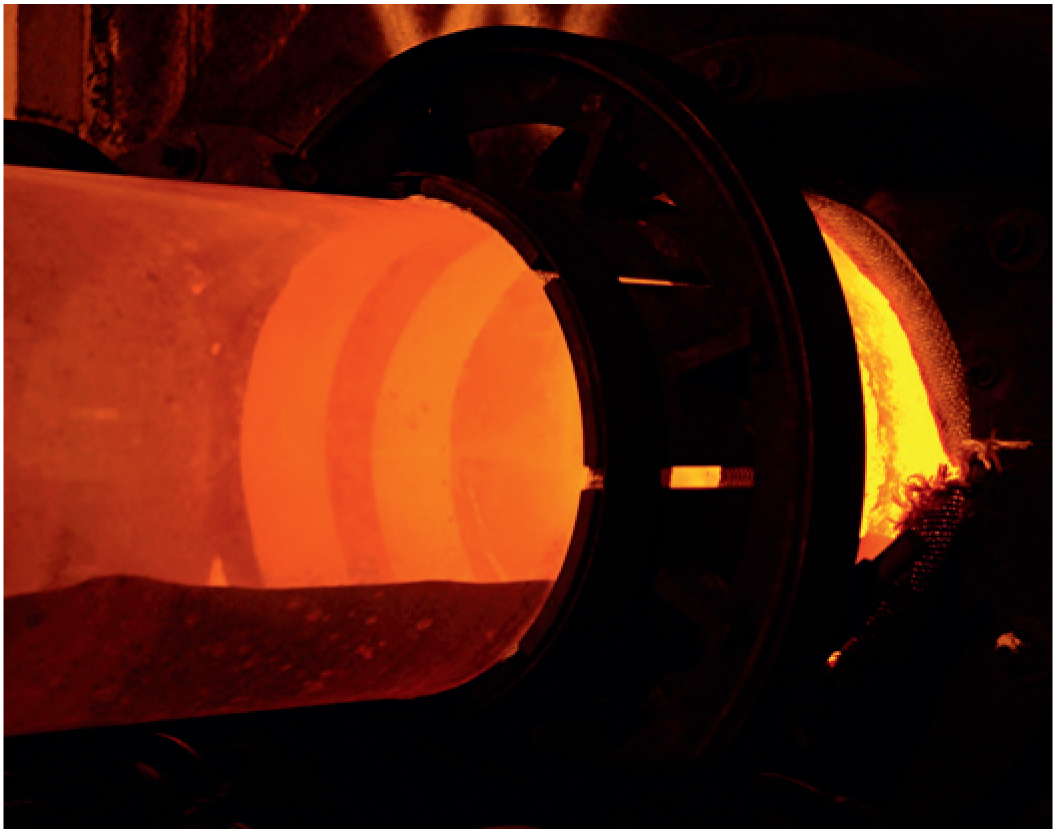
2.5 Calcination

The final crystalline phase and physical properties of calcined aluminas depend on the initial crystalline properties of the starting alumina hydrate as well as the calcination temperature. The sequence of phase transitions of boehmite and bayerite are shown in figure 7.

Physical properties such as crystalline phase, surface area and porosity can be altered significantly by varying the calcining time and temperature. Applied temperatures are typically between 600 °C and 1,100 °C. This process results in the loss of physisorbed and crystal water.

Figure 7:
Sequence of phase transitions





3. Technical data

3.1 High-density alumina hydrates

Typical chemical and physical properties		CATAPAL A	CATAPAL B	PURAL SB	PURAL SCF 55	CATAPAL C1	CATAPAL D	PURAL 200 CATAPAL 200	PURAL BT*
Solid content Al_2O_3	[%]	72	72	74	74	72	76	80	64
Na_2O	[%]	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Loose bulk density	[g/l]	670–750	670–750	600–850	500–700	670–750	700–800	500–700	500–700
Packed bulk density	[g/l]	800–1100	800–1100	800–1100	800–1100	800–1100	800–1100	700–900	600–800
Particle size (d_{50})	[µm]	60	60	45	25	60	40	40	10–20
Surface area (BET)**	[m²/g]	250	250	250	250	230	220	100	360
Pore volume**	[ml/g]	0.45	0.50	0.50	0.50	0.50	0.55	0.77	30
Crystallite size (021)	[nm]	<4.5	4.5	5.0	5.0	5.5	7.0	40	40***

3.2 High(TH)- and medium(TM)-porosity alumina hydrates

Typical chemical and physical properties		PURAL TM 70	PURAL TH 80	PURAL TM 100	PURAL TH 100	PURAL TH 200	PURAL TH 500
Solid content Al_2O_3	[%]	75	75	78	75	78	80
Na_2O	[%]	0.002	0.002	0.002	0.002	0.002	0.002
Loose bulk density	[g/l]	350–550	350–550	300–500	300–500	250–450	200–400
Particle size (d_{50})	[µm]	35	35	35	35	35	35
Surface area (BET)**	[m²/g]	200	180	150	150	110	80
Pore volume**	[ml/g]	0.75	0.9	0.9	1.1	1.2	1.3
Crystallite size (021)	[nm]	8	10	15	14	22	40

Chemical purity: C: 0.25 %, SiO_2: 0.01–0.015 %, Fe_2O_3: 0.005–0.015 %, TiO_2: 0.01–0.20 %

* Bayerite
** After activation at 550 °C for 3 hours
*** (201) reflection (bayerite)

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

4. Product information

4.1 Storage and transfer

PURAL and **CATAPAL** alumina hydrates are mildly abrasive materials with a Mohs hardness of 3.5 to 4.0. Therefore, handling and storage equipment should be abrasion resistant carbon steel, aluminium or polypropylene-lined steel are recommended.
Blower or vacuum systems are typically used to move the product. A minimum of 4,000 ft/min fluidizing velocity is recommended. Since alumina will adsorb atmospheric moisture facilities should be designed to avoid moist air contact with alumina.

4.2 Safety and handling

PURAL and **CATAPAL** are classified as a non-toxic, nuisance dust. Exposure to high concentrations of dust may cause physical irritation.

Repeated or prolonged contact with skin may result in drying and irritation. Handling procedures should be designed to minimize inhalation and skin exposure. Normal good housekeeping and operating procedures should ensure personnel safety. See also corresponding material data safety sheet.

4.3 Technical support

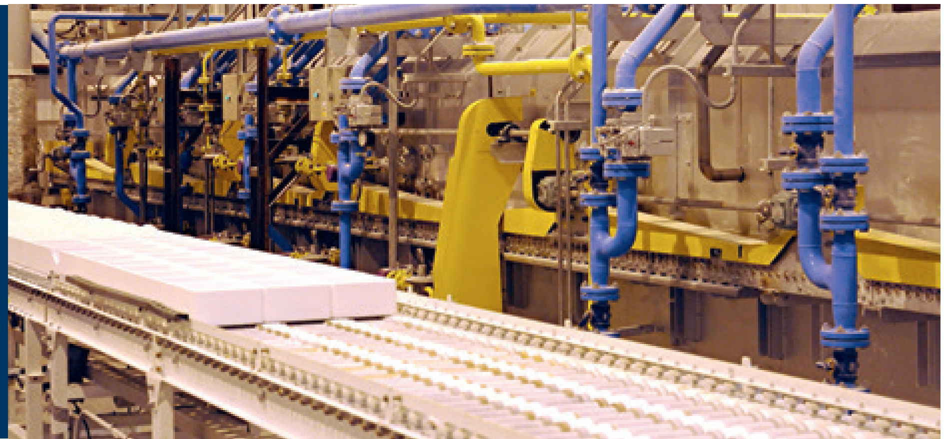
Sasol is committed to customer satisfaction and we offer a full range of technical support to complement the products. Technical sales and support is available worldwide to help choose the right alumina for your end use, as well as to provide advice on the aluminas' safe and efficient use.

The products described in this brochure are small indications of our capability. We look forward to discussing specific technical requirements with you, in detail, so that together we can develop unique products for your application.

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.




anhydro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6. Analytical methods

Tests on PURAL and CATAPAL

6.1 Trace element analysis

Alumina hydrate powder is quantitatively brought into solution by using acids and then analyzed by ICP, atomic emission. Additionally, X-ray fluorescence spectroscopy is used.

6.2 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.

6.3 Particle size distribution

The particle size distribution of alumina may be measured by various instruments, namely, Cilas Granulometer 1064 supplied by Quantachrome, Malvern Mastersizer or Luftstrahlsieb (air sieve) supplied by Alpine.

6.4 Surface area analysis

The boehmite is first calcined at 550°C for three hours in preparation for analysis. The surface area of PURAL and CATAPAL is measured by using an instrument supplied by Quantachrome (Nova series) or by Micromeritics (Gemini series). The method entails nitrogen adsorption at the BET region of the adsorption isotherm.

6.5 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.

6.6 Differential scanning calorimetry (DSC)

Netzsch STA 449C Jupiter, Setaram 92 or Perkin Elmer instruments may be used with a selected heating rate to obtain the exothermic and endothermic transitions of alumina. Additional test methods are available for other physical properties upon request.

6.7 Nitric acid gelation (NAG)

200 g of powder is dispersed in 234,5 g of distilled water and is then stirred for exactly 3 minutes. 98 ml of 3.93% nitric acid is then quickly added under stirring to create a 37.5 weight % dispersion. The viscosity of the dispersion is then measured. The NAG value is defined as the time required for the dispersion to gel to 9,500 mPa·s from the time that the acid is added.

Additional test methods are available for other physical properties upon request.

At your service

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Source reference:
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