THE EFFECT OF PARTICLE SIZE OF α-Al_2O_3 ON RHEOLOGICAL PROPERTIES OF SLURRIES

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The rheological character and the viscosities of aqueous alumina slurries with particle sizes between 0.62 and 1.9 μm are determined by rotational viscometer measurements. It is shown that the optimum electrolyte concentration in the slurries is clearly proportional to the specific surface of the powder contained and that the viscosity of the slurry (for this optimum electrolyte concentration) increases with increasing powder surface. Thus, apart from the solid phase and electrolyte content, the powder particle size is of principal importance for the rheological properties of the slurry. The maximum solid phase content for slip-casting and the long-term stability are determined for the respective slurries.

INTRODUCTION

Corundum ceramics, that is ceramic materials based on α-Al_2O_3, belong beyond any doubt among the most prospective materials of our time. The performance properties and the chemical purity of Al_2O_3 depend on the properties of the initial components and on the conditions of the technological processes. Numerous methods for the production of aluminium oxide have been proposed and also implemented, and are used in dependence on the characteristics of the respective raw material.

Most existing alumina ceramics production plants cope up with the purity of Al_2O_3 prepared by the Bayer process [1]. However, special oxide ceramics require the aluminium oxides to meet strict requirements for chemical purity and morphological properties. The powdered alumina used as initial material for the manufacture of special ceramics is prepared by special chemical processes based on controlled nucleation and particle growth during their formation. The sol-gel method based on controlled hydrolysis of organometallic compounds, in particular alkoxides in the form of ethanolates, propyl alcoholates, isopropyl alcoholates, and the like, is the most frequently employed chemical process used in the preparation of powders for Al_2O_3 ceramics [2]. Another alternative is based on precipitation from solutions of inorganic compounds in the form nitrates, sulphates, chlorides, etc. An organic and an inorganic way are thus available for the preparation of high-purity Al_2O_3 powders.

The particle size, its distribution, the shape of particles and the presence of agglomerations depend in particular on selection of the initial compound, on concentration of the initial solution, on the type and concentration of the precipitating agent, on temperature, pressure, agitation intensity, on the method of drying, on calcination of the powders and on many other factors [3].

The technological process used in the preparation of the powders has already been well mastered even on an industrial scale. The inorganic process of powdered Al_2O_3 production is used by Alcoa Industrial Chemicals Europe, and hydrolysis of organometallic compounds is employed by Sumitomo Chemical Co. Ltd. and others. In the present study, the series of AA-05, AA-07, AA-2 and AKP 15 Al_2O_3 powders produced by Sumitomo Chemical Co. Ltd. Japan was investigated.

Casting of aqueous slurries called slips is one of the oldest and technologically as well economically most prospective methods of forming ceramic products. It is based on pouring the slips into gypsum moulds which absorb water from the slurries and thus form a green body following the shape of the mould.

From the standpoint of macrorheology, ceramic slurries are assessed according to the dependence of deformation rate D (s^{-1}) on shear stress τ (Pa). The most significant rheological property of the slurries or slips is viscosity (η = tg α). The rheological properties of aqueous casting slips can be adjusted to a considerable degree. For example, a small addition of an electrolyte can reduce the viscosity by 2 or 3 orders; the slurry is thus deflocculized and its rheological character is changed.

As far as establishing of equilibrium between the stress applied and its corresponding deformation rate is concerned, time-dependent and time-independent viscoplastic liquids are distinguished [4] (cf. figure 1). The latter case covers the instantly established equilibrium, the former the time-dependent liquids (a hysteresis loop appears in the rheogram).

With ideally viscous liquids, represented by the Newtonian liquid, the course of the deformation rate is linear in dependence on stress. Such a behaviour is exhibited by slurries with dispersed particles of spherical shape.

Deviations from the linear course of rheological curves are exhibited by so-called non-Newtonian liquids;

this can be explained by mutual effects between the particles in suspension. For such liquids, the term apparent viscosity η_z has been introduced. It is expressed by the ratio of τ to D; for example, at $D = 48.6\ s^{-1}$.

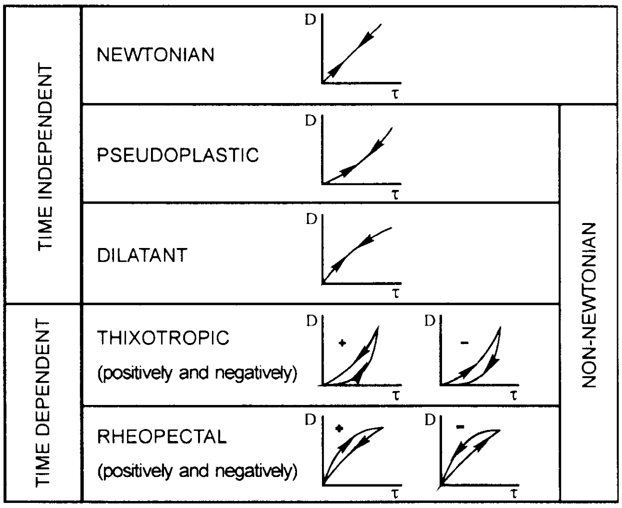

Figure 1. Rheological curves of time-independent and time-dependent liquids.

The non-Newtonian liquids include pseudoplastic ones, with which an infinitesimal shear stress brings about motion but with which the increase in deformation rate in terms of stress rises, so that the apparent viscosity decreases. This phenomenon is explained by the existence of freely bound aggregations or clusters which readily fall apart with increasing shear stress, and conversely reform when the stress decreases.

In the case of another type of non-Newtonian liquids, called dilatant ones, the increase in the deformation rate decreases in dependence on stress, so that the apparent viscosity grows. This behaviour is explained by a weak bond between water and the surface of the solid phase (grog). Water films of low strength allow the particles to come so close together that friction between the solid surfaces occurs. If the surface of a solid is covered with a continuous hydrophilic film (at low deformation rates) the dilatance disappears, although the concentration has not changed. This property of dilatant behaviour of slips has to be taken into account when using technologies with higher deformation rates, such as spray drying, during which viscosity is likely to increase enormously.

In determining the rheological character of a slurry (dilatance or pseudoplasticity) use is made of comparing apparent viscosity values for various deformation rates (e.g. for $D = 48.6\ s^{-1}$; $1312\ s^{-1}$), thus obtaining a ratio which can be called the coagulation rate S_C; for example, $S_C = \dfrac{\eta_{48.6}}{\eta_{1312}}$.

If $S_C < 1$, a dilatant slurry is in question (the slurry usually contains excess deflocculant), if $S_C = 1$, the slurry is Newtonian, and if $S_C > 1$, it is pseudoplastic (usually insufficiently deflocculated or coagulated).

The liquids exhibiting slow changes in the rheological properties, i.e. slow establishing of equilibrium between D and τ, are said to be time-dependent.

This the case of thixotropic slurries which show a decrease of shear stress in the course of time when the deformation rate is constant. Thixotropy is an important phenomenon in particular for the slip casting technology where the slip viscosity increases and thus the liquidity worsens in the course of time.

Rheopexy is the behaviour when at a constant deformation rate the structural regeneration prevails over structural impairment; it tends to occur with slurries of higher concentration and with pastes.

Preparation of high-grade products requires the ceramic slurries to meet the requirements established on the basis of long-term experience with slip-casting technology. The quality of the casting slip affects not only the final properties of the ceramics after firing, but also the overall course of formation of the green ceramic body, its solidification and subsequently its firing. A perfectly deflocculated slip gives a dense body which, however, forms slowly as a result of the dense arranging of the particles. A suitable compromise must therefore be chosen in technological practice [5,6,7,8].

The properties of the slurry depend first of all on the properties of the starting powder, on the type and amount of the deflocculant employed, and on the way the slip is prepared (such as on the length of its homogenization). The properties of high-grade casting slips can be summarized into the following points:

- low viscosity
- low, virtually zero yield point at a high content of solid phase and a low content of electrolyte
- ready elimination of the deflocculant by heat treatment
- short time of formation and solidification of high-quality green body
- minimum corrosive effects of the slip on the porous mould.

The effect of the starting powder on the quality of the slip is associated with the properties of the particle system characterized by the size and the distribution of the particles, their shape, the presence of aggregations, by chemical purity and crystallographic modification.

EXPERIMENTAL PART

The experimental part of the study was concerned with the commercially produced powders of α-Al_2O_3 manufactured by Sumitomo Chemical Co. Ltd. in Japan. The materials in question differ in their particle size and shape, their specific surface area and the content of admixtures. The basic specification of the powders are given in table 1 [9]. The fineness of the powdered materials is expressed by means of statistical characteristics, namely by arithmetic mean particle size and by specific surface area. The shapes of particles of the individual raw materials are shown in figures 2 through 4.

The aqueous slurries of the individual powder types were prepared as follows: The weighed calculated amount of powdered α-Al_2O_3 was mixed in a PVC bottle with a certain amount of deflocculant and made up with water to the respective value of dry matter content. The slurry was then homogenized for 90 minutes with corundum balls (proportion by weight: dry matter:corundum balls = 1:1) in a shaker and evacuated twice for 10 minutes. Between the evacuations, the slurries were treated by ultrasound to disperse any possible remaining aggregates of grains.

The rheological behaviour of slurries can be quantitatively described by the dependence of deformation rate

Table 1. Basic parameters of the powders made by Sumitomo Chemical Co. Ltd.

powder designation	AA-05	AA-07	AA-2	AKP-15
crystaline phase	α-Al_2O_3	α-Al_2O_3	α-Al_2O_3	α-Al_2O_3
oxide content (wt.%)	> 99.9	> 99.9	> 99.9	> 99.99
average particle diameter (μm)	0.52	0.84	1.9	0.7
specific surface area (m^2 g^{-1})	3.1	2.5	1.0	3.1
particle shape	spherical	spherical	spherical	spherical to oval
agglomerates	none	none	none	none
amount of admixtures (ppm)				
Si	5	4	7	< 40
Fe	6	< 2	< 2	< 20
Na	< 5	< 5	< 5	< 10

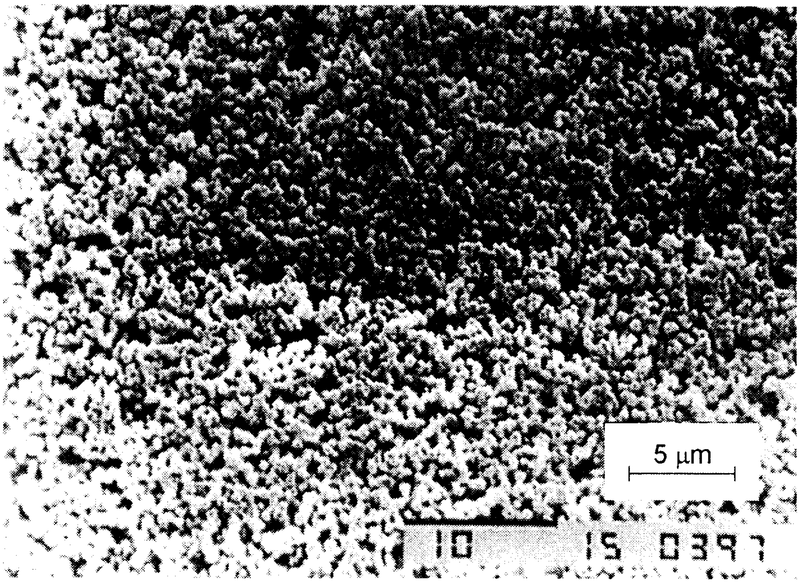

Figure 2. The shapes of particles of α-Al_2O_3 powder AA-05.

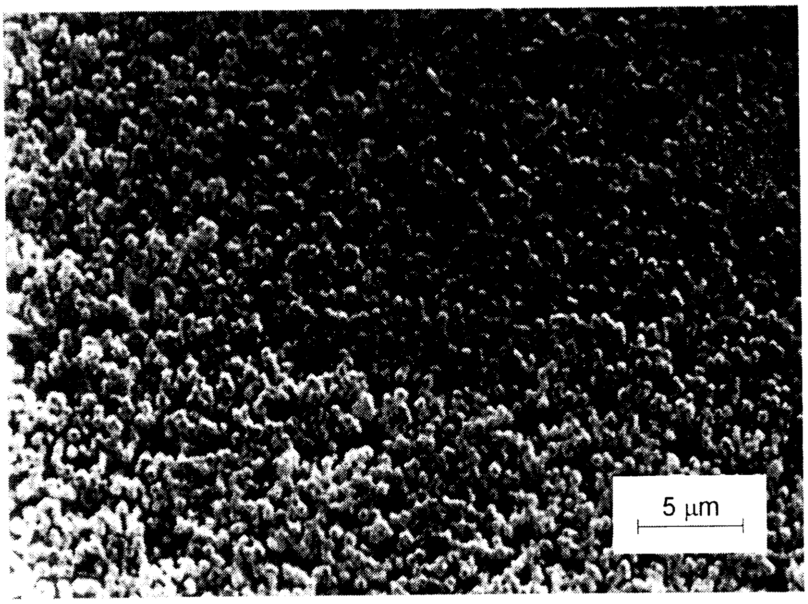

Figure 3. The shapes of particles of α-Al_2O_3 powder AA-07.

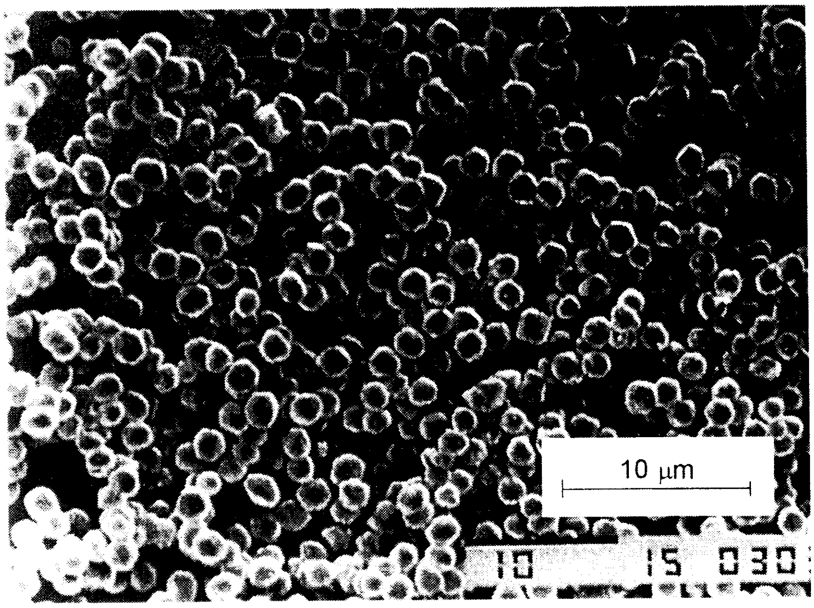

Figure 4. The shapes of particles of α-Al_2O_3 powder AA-2.

D on tangential stress τ acting in the slurry. This dependence was measured by the RHEOTEST 2 rotary viscometer.

The apparent viscosity η_z was determined from the relationship $D = f(\tau)$ measured at rate degree 6a, which corresponds to the deformation rate gradient of $D = 48.6\ s^{-1}$ and was as a rule determined from the ascending branch of the rheological curve.

For the purpose of establishing the suitable type of deflocculant, a slurry of the AA-05 with a solid phase content of 78 wt.% was prepared and treated with several deflocculants of the TRUSAN and DOLAPIX series. The addition was related to dry matter weight. The best results were achieved with the Dolapix PC 21 and Trusan 480 deflocculants. The latter was then evaluated as the most suitable one and thereafter used in all of the experiments.

This deflocculant is produced by the German firm TRUKEM. It is completely alkali-free and miscible with water at all proportions. Its other properties given by the manufacturer are listed in table 2 [10].

Table 2. Characteristics of the Trusan 480 deflocculant.

	pH	density (g cm^{-3})	effective substance (wt.%)
TRUSAN 480	10.3	1.12	69.0

The optimum addition of the deflocculant corresponds to the minimum value of apparent viscosity of the slurry read off the deflocculation curve, i.e. η_z = f(content of deflocculant in wt.%). For this determination, slurries with a 78 wt.% content of the solid phase were prepared from the individual powders. On the basis of evaluation of the viscosities attained with the various amounts of the deflocculant, the dependence of η_z on the content of the deflocculant was determined for the individual powders. The dependences are plotted in figure 5. The curves served for establishing the optimum amounts of the deflocculant and the corresponding values of apparent viscosity, the values of which are listed in table 3.

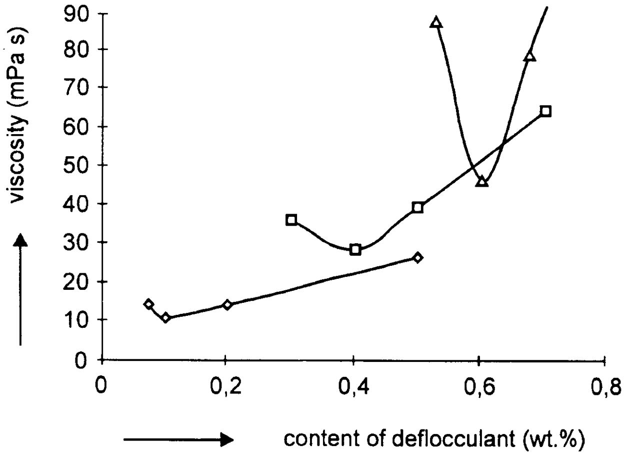

Figure 5. Apparent viscosity vs. deflocculant content for 78 wt.% suspensions of AA-2, AA-07, AA-05.
◊ - AA-2, □ - AA-07, Δ - AA-05

The maximum contents of solid phases in slurry were determined for the individual powder types at the optimum deflocculant content. With all the powders the solid phase concentrations were increased from 70 wt.% gradually by 4 wt.% up to the limit of solid phase concentration which could be evaluated at D = 48.6 s^{-1}. At still higher D values the shear stress exceeded the viscometer scale range. The rheological relationships established were used to determine the apparent viscosities at D = 48.6 s^{-1} and from them to establish the dependence of viscosity on solid phase content for the individual powders (cf. figure 6).

Table 3. Optimum deflocculant addition for 78 wt.% slurries of AA-05, AA-07 and AA-2, and their apparent viscosity.

78 wt.% slurry of powder	AA-05	AA-07	AA-2
optimum deflocculant addition (wt.%)	0.6	0.4	0.1
viskosity at optimum deflocculant addition (mPa s)	46.8	28.8	10.8

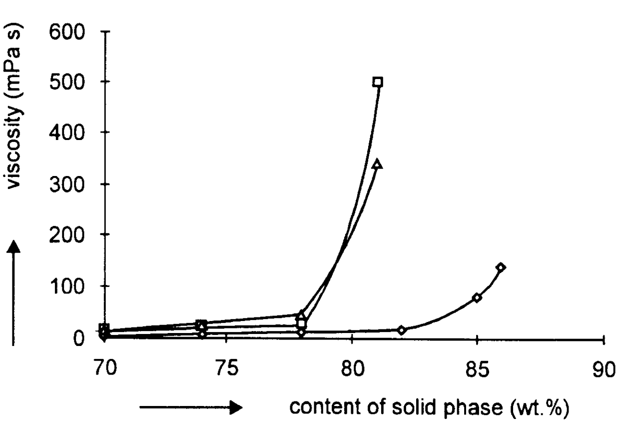

Figure 6. Apparent viscosity vs. solid phase content for AA-2, AA-07 and AA-05 slurries.
◊ - AA-2, Δ - AA-05, □ - AA-07

The maximum contents of the solid phase correspond to the state of the slurry which meets the conditions for slip casting, where any additional increase in the content of solid phase would lead to a steep increase in viscosity. The evaluated maximum contents of the solid phase are listed for the individual slurries in table 4.

Table 4. Maximum solid phase content for slurries AA-05, AA-07 and AA-2 at optimum deflocculant addition.

slurry of powder	AA-05	AA-07	AA-2
max. solid phase content (wt.%)	81	81	86

The maximum contents of solid phases are limit values, and for this reason so-called working dry matter contents of casting slips were established in order to assess their stability, to determine their rheological characteristics, or to cast test specimens. These working contents (at which the slips have a viscosity of 100 mPa s and less) are lower by approximately 3 wt.% than the established maximum solid phase content values, but allow for easier preparation of the slurries (easier homogenizing and evacuation).

The rheological character of the slurries was evaluated graphically at a content of 78 wt.% of the solid phase and with the optimum amount of the deflocculant. The experimentally established dependences $D = f(\tau)$ for the slurries of the individual powders are compared in figure 7.

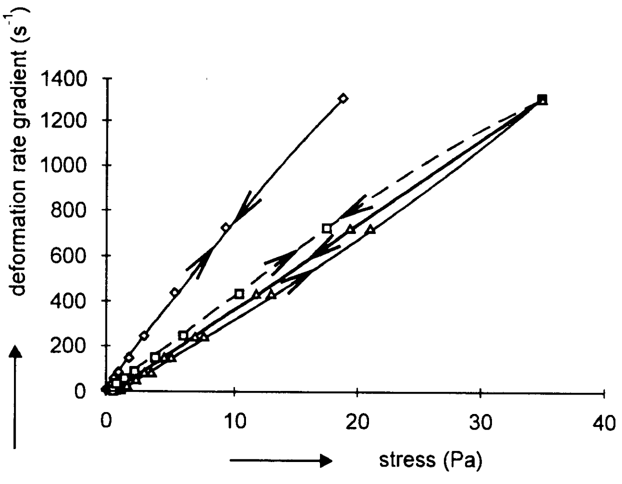

Figure 7. Rheological curves of 78 wt.% slurries of AA-2, AA-05 and AA-07 at optimum deflocculant addition for 78 wt.% AA-07 slurry.
◊ - AA-2, Δ - AA-05, □ - AA-07

On the basis of evaluation of the graphic relationships and of the coagulation degree S_C ($S_C = \eta_{48.6} / \eta_{1312}$) the behaviour of the slurries of the individual powders with a 78 wt.% content of the solid phase can be described by the following rheological models:

- rheological behaviour of powder AA-2 slurry can be described by the time-independent model of a Newtonian liquid of dilatant character, S_C = 0.76.
- rheological behaviour of powder AA-07 slurry can be described by the time-independent model of a close-to-Newtonian liquid, S_C = 1.08.
- rheological behaviour of powder AA-05 slurry can be described by the time-dependent model of a non-Newtonian liquid with a mild hysteresis loop (positively thixotropic), S_C = 1.76.

Table 5 demonstrates the dependence of S_C on the various content of dry matter for slurries of AA-05, AA-07 and AA-2 with the optimum deflocculant addition.

The rheological behaviour of 78 wt.% slurries of two different powder series AA-07 and AKP 15 can be compared in figure 8. The slurry prepared from powder AKP 15 exhibits a lower viscosity than that prepared from powder AA-07 (cf. table 6) in spite of having a larger specific surface area and containing some particles of oval shape (cf. table 1).

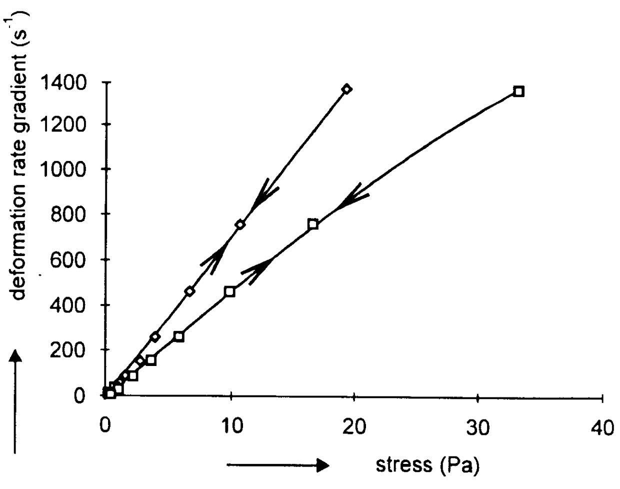

Figure 8. Rheological curves of 78 wt.% slurries of AA-07 and AKP 15 at optimum deflocculant addition for 78 wt.% AA-07 slurry.
◊ - AKP-15, □ - AA-07

A comparison or rheological curves of slurries with the optimum deflocculant addition, i.e. those exhibiting the lowest viscosity, with the curves of slurries with other than optimum additions of deflocculant, is shown in figure 9. The comparison made use of 78% slurry of powder AA-07 where the slurry with the optimum content of deflocculant (0.4 wt.%) and that with a lower one (0.3 wt.%) behaved approximately as a Newtonian liquids. A slurry with a high deflocculant addition (0.8 wt.%) can be described by the time-dependent model of non-Newtonian liquid (positively rheopective),

Table 5. Coagulation degree ($S_C = \eta_{48.6} / \eta_{1312}$) vs. various solid phase contents for slurries AA-05, AA-07 and AA-2, at optimum deflocculant addition.

powder suspension	AA-05			AA-07			AA-2		
dry matter (wt.%)	70	74	78	70	74	78	70	74	78
$S_C(\eta_{48.6}/\eta_{1312})$	1.19	1.59	1.76	0.51	0.51	1.08	0.46	0.47	0.76

i.e. one showing viscosity increasing with the time of agitation.

Table 6. Viscosities of 78 wt.% slurries of AA-07 and AKP 15 at optimum deflocculant addition for 78 wt.% slurry of AA-07.

78 wt.% slurry of powder	AA-07	AKP-15
viskosity at optimum deflocculant addition for AA-07 (mPa s)	28.8	21.6

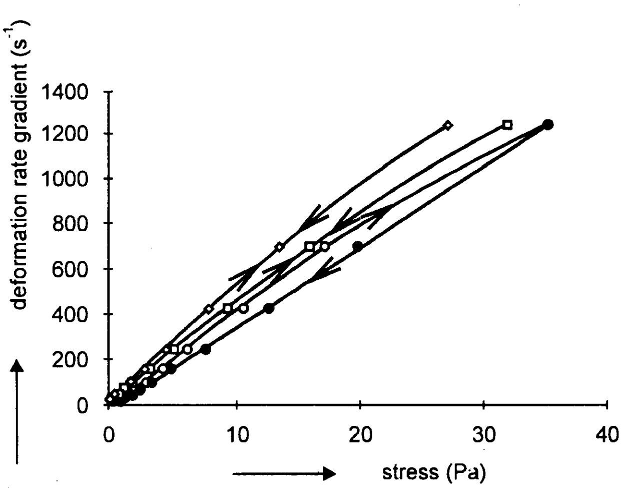

Figure 9. Rheological curves of 78 wt.% slurries of AA-07 at optimum deflocculant addition (0.4 wt.%) and other deflocculant additions (0.3 and 0.8 wt.%).
● – AA-07 (0.8 wt.% of deflocculant), ◊ – AA-07 (0.4 wt.% of deflocculant), □ – AA-07 (0.3 wt.% of deflocculant)

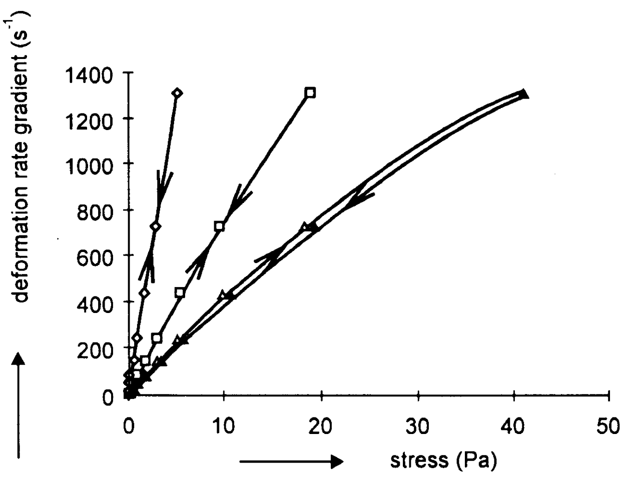

Figure 10. Rheological curves of AA-2 slurry with 70, 78 and 82 wt.% of solid phase.
◊ – AA-2 (70 wt.% of solid phase), □ – AA-2 (78 wt.% of solid phase), ▲ – AA-2 (82 wt.% of solid phase)

A comparison of the rheological behaviour of suspensions with various contents of the solid phase (in wt.%) was carried out on slurry of the AA-2 powder which contained the optimum amount of deflocculant recalculated for the given dry matter concentration (cf. figure 10). The slurry with a solid phase content lower than 78 wt.% behaved in a dilatant way, while the slurry with a higher than 78 wt.% content can be described by the time-dependent model of a non-Newtonian liquid (positively rheopectant).

The slurries may be assessed as stable ones when their viscosity does not change by more than 10 % of the original value. The measurements were performed on 78 wt% slurries of the individual powders with the optimum deflocculant addition. The stability can be assessed in two ways: either from the aspect of deflocculation stability, or from that of stability with respect to sedimentation of the suspended particles.

The evaluation of deflocculation stability due to the deflocculant employed was effected by measuring the rheological curve of the individual powders (D = f(τ)) immediately after sample preparation, then keeping the slurry standing for 1 hour, agitating it with a glass rod and measuring again its rheological curve. The procedure was repeated six times with each slurry, i.e. for a period of 6 hours. The rheological relations were used for calculating apparent viscosities at D = 48.6 s^{-1}, and from these the dependence of viscosity on the time of standing was established. The resulting graphic relations are plotted in figure 11. The curves indicate that the slurries of powders AA-07 and AA-2 exhibited excellent stability even after 6 hours. Increasing viscosity was observed on the slurry of powder AA-05.

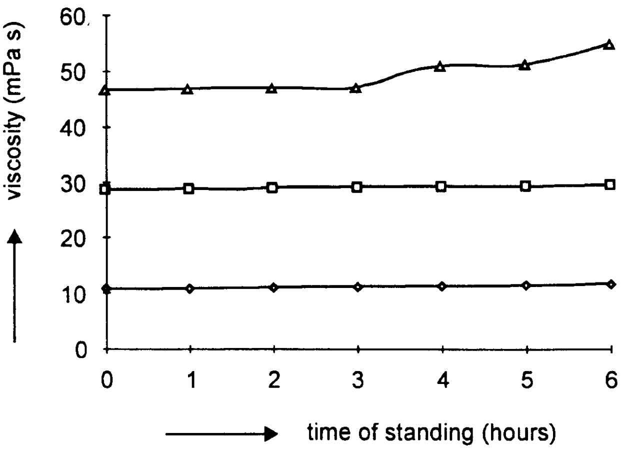

Figure 11. Stability of deflocculant effect with 78 wt.% slurries.
◊ – AA-2, Δ – AA-05, □ – AA-07

The deflocculation stability in terms of sedimentation of particles was determined so that following first measurement on the rotary viscometer effected just after the sample preparation the slurry was left for one hour to stand and then was measured without previous agitation. The procedure was repeated six times with each slurry, i.e. for a period of 6 hours. The results were evaluated in the same way as in the precious case (cf. figure 12). Slurries of powders AA-05 and AA-07 exhibited stability for up to 5 hours, those of powder AA-2 up to 3 hours.

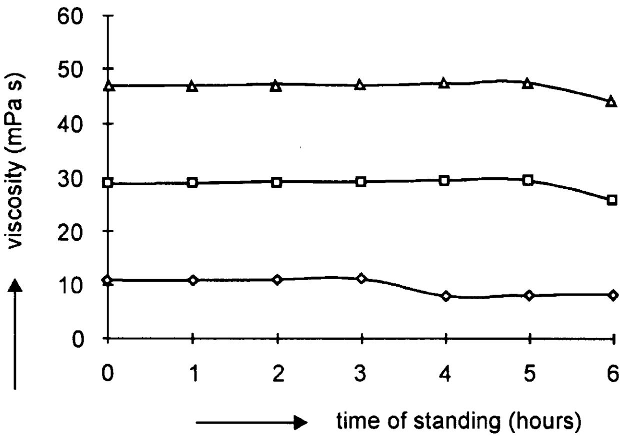

Figure 12. Stability of 78 wt.% slurries with respect to sedimentation.
◊ - AA-2, Δ - AA-05, □ - AA-07

DISCUSSION

The experiments with slurries of powdered alumina made by Sumitomo Chemical Co. Ltd. of Japan, of the series AA-05, AA-07, AA-2 and of powder AKP 15, with mean grain sizes of 0.52, 0.84, 1.9 and 0.7 μm respectively, showed that the optimum deflocculant content in 78 wt.% slurries of the individual powder types was directly proportional to the specific surface area and thus indirectly proportional to the mean particle size. The larger the specific surface area, the more deflocculant had to be added to the same weight of the powder to achieve the minimum viscosity. The optimum deflocculant addition therefore increased in the sequence of powders AA-2 (0.1 wt.%), AA-07 (0.4 wt.%), AA-07 (0.6 wt.%).

The experimental investigations also showed that the viscosity of the slurry at the optimum deflocculant content increases with increasing specific surface area of the particles. This relationship, established for slurries of powders of series AA, does not hold for the powder of the AKP series. The rheological properties of 78 wt.% slurries were compared for slurries of powders AA-07 and AKP 15. The measurements were carried out with the optimum amount of deflocculant for 78 wt.% slurry of AA-07. The AKP 15 slurry showed a lower viscosity than the AA-07 one in spite of the former having a somewhat larger specific surface area and containing also particles of oval shape. This discrepancy was probably due to the presence of admixtures in the α-Al_2O_3 powders (table 1), or in a different production technology employed in the preparation of series AA and series AKP powders (the production technology is held confidential by the manufacturer).

A comparison of the values of coagulation degree S_C at a 78 wt.% dry matter concentration (with the optimum deflocculant addition) indicates that the rheological character of the slurries changes in dependence on the grain size of the powders. The slurry prepared from the coarsest powder (AA-2, 1.9 μm) behaved in a dilatant manner, the slurry with the medium-fine powder (AA-07, 0.84 μm) was of approximately Newtonian character, and the slurry of the finest powder (AA-05, 0.52 μm) was pseudoplastic.

Examination of the effect of solid phase concentration revealed a change in rheological behaviour of the slurries (table 5). Whereas an increase in dry matter concentration in the slurry of the coarsest powder (AA-2) according to S_C did not bring about any change in the dilatant character which, however, becomes time-dependent at the highest concentration, rheopectal (figure 10), with the medium grain-size slurry AA-07 an increase in concentration caused the character to change from the dilatant to the Newtonian one, and in the case of the finest AA-05 powder the increase in concentration resulted in a deflection from the Newtonian character towards an increasingly pseudoplastic one (possibly time-dependent, thixotropic, figure 7), similarly to the rheological behaviour of clay and kaolin slurries.

The maximum solid phase content in slurry was identical for the slurries of the AA-05 and AA-07 powders (81 wt.%). It was much higher in the case of the AA-2 powder suspension (86 wt.%). These contents correspond to the condition of slurries which still meet the requirements for slip-casting, where the dilatant slurry of powder AA-2 at viscometer speed 6a (D = 48.6 s^{-1}) had a viscosity of η = 150 mPa s and did not flow any more at speed 7a (D = 81 s^{-1}). The remaining two slurries exhibited viscosities of η = 350 mPa s (AA-05) and η = 500 mPa s (AA-07).

It was shown that the rheological character of the slurries was likewise affected by concentration of the respective deflocculant. A higher than normal addition brings about the time-dependence of the slurry (figure 9).

The time stability of the 78 wt.% slurries of the individual powders prepared with the optimum deflocculant additions was examined by two methods. in the first one, the slurry was agitated with a glass rod before each measurement, so that the stability of the deflocculant effect was determined. In the case of the AA-05 powder slurry, which had the largest specific surface area, the viscosity was found to increase mildly after 3 hours. The AA-07 and AA-2 slurries retained their viscosity for the whole 6-hour period.

The other method differed in that the sample was not agitated before the second measurement, so that the stability with respect to sedimentation was established. After 3 hours, slurry AA-2 exhibited a mild decrease of viscosity due to separation of the relatively large particles. Slurries AA-07 and AA-05 showed a merely minute decrease of viscosity within 5 hours, and were thus more stable than the AA-2 one.

CONCLUSION

Experiments with powders of various mean particle sizes (0.52, 0.84, 1.9 μm) of the series produced by Sumitomo Chemical Co. Ltd. of Japan showed that the optimum content of deflocculant in slurries of the individual powders was distinctly proportional to their specific surface area. Also, that the viscosity increases with increasing specific surface area of slurries of the powders prepared in the same way (series AA) and with the optimum amounts of deflocculant. Slurries with 78 wt.% dry matter concentration exhibited different rheological characteristics. The slurry prepared from the coarsest powder behaved in a dilatant manner, that with the medium mean grain size had Newtonian behaviour and the slurries of the finest powder showed pseudoplastic or even thixotropic rheological properties, i.e. time-dependent ones.

Increasing the concentration of the solid phase over the 70 to 78 wt.% range brings about various trends in the behaviour of the slurries. Whereas the slurries with the coarsest powder did not change their dilatant behaviour, the slurries of the medium grain size powder gradually gave up their dilatant behaviour replacing it with a Newtonian one, and the slurries of the finest powders gradually lost their Newtonian character, turning into a pseudoplastic or even into a time-dependent, thixotropic one.

An increase in the content of deflocculant above the optimum brings about a time-dependent character of the slurry.

The maximum content of the solid phase meeting the requirements for slip-casting increases with increasing particle size.

The stability of the effect of the deflocculant is shortest with slurries of the smallest mean grain size powder (3 hours). The sedimentation stability is shortest with the slurry of the coarsest powder.

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VLIV VELIKOSTI ČÁSTIC α-Al_2O_3 NA REOLOGICKÉ VLASTNOSTI SUSPENZÍ

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Je sledováno chování suspenzí z komerčně připravených prášků α-Al_2O_3, které produkuje firma Sumitomo Chemical Co., Ltd. Japan řady AA-05, AA-07, AA-2 a AKP 15. Použité výchozí suroviny se vzájemně odlišují průměrnou velikostí částic (0,52; 0,84; 1,9 a 0,7 μm), tvarem a obsahem příměsí (viz tab.1).

Příprava vodných suspenzí s přídavkem ztekutiva Trusan 480 sestávala z 90 min homogenizace na třepačce, dvojího 10 min vakuování, mezi kterým bylo provedeno 10 min rozdružení ultrazvukem.

Měření reologických vlastností probíhalo na rotačním viskozimetru Rheotest 2. Ze stanovených reologických křivek byla vyhodnocována zdánlivá viskozita η_z při gradientu rychlosti deformace $D = 48{,}6\ s^{-1}$.

Experimenty ukázaly, že optimální obsah ztekutiva suspenzí jednotlivých prášků je zřetelně přímo úměrný měrnému povrchu. Dále, že s rostoucím měrným povrchem, stejným způsobem připravených prášků (řada AA), roste viskozita suspenze při optimálním přídavku ztekutiva. Suspenze o 78 hmot.% koncentraci prášku vykazují různý reologický charakter. Suspenze připravená z nejhrubšího prášku se chová dilatantně, suspenze ze středně jemného prášku newtonsky a suspenze z nejjemnějšího prášku pseudoplasticky až tixotropně, tj. časově závisle.

Zvyšování podílu pevné fáze v intervalu 70-78 hmot.% vykazuje různou tendenci v reologickém chování suspenzí. Zatímco u suspenze z nejhrubšího prášku nedochází ke změně dilatantního chování, u suspenze ze středně jemného prášku dochází ke změně od dilatantního k newtonskému chování a u suspenze z nejjemnějšího prášku znamená toto zvyšování koncentrace odklon od newtonského charakteru k pseudoplastickému až časově závislému - tixotropnímu.

Zvýšení obsahu ztekutiva nad optimum vyvolá časově závislý charakter suspenze.

Maximální obsah pevné fáze suspenzí splňujících podmínky pro vytváření litím roste s rostoucí velikostí částic.

Časová stabilita působení ztekutiva je u suspenze z nejjemnějšího prášku nejkratší (3 h). Sedimentační stabilita je nejkratší (3 h) u suspenze z nejhrubšího prášku.