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# STUDY OF ALUMINA BEHAVIOR IN SMELTING PLANT STORAGE TANKS

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Field samples from inside the alumina storage tanks clearly indicate that significant size segregation can occur and the segregated fines can accumulate at the valleys between piles and at the periphery of a tank. This mode of segregation, caused by the airborne conditions, is a sharp contrast to the classical segregation. The segregated fines show profoundly different handling characteristics from the bulk of alumina particles. It is also demonstrated that other physical and chemical properties vary considerably among the segregated fractions. Possible mechanisms for the size segregation of alumina in storage tanks are discussed in terms of pulvation, secondary air currents, air slide feeding, etc.

## Introduction

As the demand for better alumina handling and cell control is increasing, the need to optimize alumina characteristics becomes more urgent. It is then important that the handling properties of alumina be quantified and subsequently various mechanisms responsible for handling problems be studied to develop economic solutions. One of the most cited handling problems has been size segregation.

Size segregation of alumina can occur during belt conveying, pneumatic transport, etc., but most severely during filling of storage bins. Segregation of size fractions results in problems such as flushing or inability to convey, dustiness, irregular pot feeding and unbalanced distribution of impurities.

Most of the studies on particle segregation in the literature concern segregation due to sifting or percolation of fine particles through the voids formed by larger particles. In this mode of segregation, coarser particles tend to gather at the periphery of a storage tank. For this mode to be dominant, feeding of the powder into the storage tank is evenly distributed or the particles are large enough not to be affected by turbulent air flow inside the tank. When there is significant airborne movement, interaction of a cloud of fine particles with the surrounding air cannot be assumed to be that of individual particles and segregation can occur by a different mechanism (1).

Size segregation of alumina in storage tanks has been widely known to exist in many systems. The extent of the problem varies and depends on many factors. However, there has been only one published study of size segregation inside alumina storage tanks. Connally recently reported tests conducted on silos at an alumina plant (2). He attributed the slight segregation of coarse particles at the edge of a tank to fine particles sifting as the predominant mechanism. The maximum segregation mentioned in that study was represented by only 3% -45 μm due to multiple feeding ports used.

It is the purpose of this study to report on field samples collected from alumina storage bins of various configurations and infer the possible segregation mechanisms inside the bins. Segregated fractions of alumina will be characterized for handling behavior and other properties potentially affecting smelting operations.

## Experimental

Aluminas used in Alcoa smelting plants originate from within as well as outside the company through exchange arrangements. The configuration of storage systems at smelting plants also varies. For a preliminary investigation of the nature of segregation phenomenon, two smelting plants were selected for sampling. Storage tanks of various configurations at these plants were studied. The configurations of the tanks tested are given in Figure 1. Some tanks were sampled once. Others were sampled twice at two different stages of a filling cycle so that two levels of alumina piles were sampled.

Samples were collected at different positions inside the tanks using a 0.9-m long powder sampler with three large openings across the length.

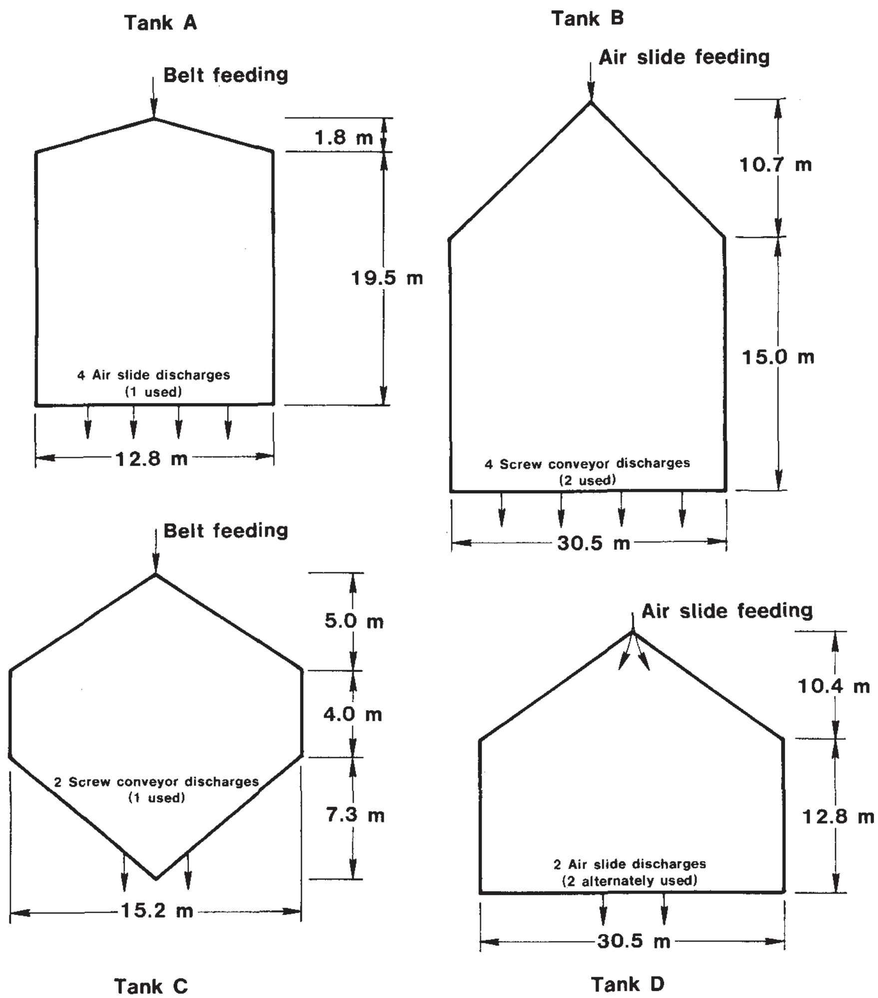


Figure 1 - Configurations of storage tanks studied

The sampler was driven into the pile beneath the surface to obtain a composite sample in the vertical direction. For Tanks C and D, samples were also collected from the top layers of piles within 2 cm of the surface.

The alumina samples thus obtained were than analyzed for particle size distribution by a Microtrac Particle Size Analyzer (Leeds & Northrup). The Powder Characteristics Tester (by Hosokawa Micromeritics Laboratory, Japan) was used to determine various handling properties such as angles of flow (repose, fall, and spatula), bulk densities, compressibility and cohesion. The tester was designed based on the test methods published by R. L. Carr, Jr. (3). A flow funnel test was also conducted in a 10-degree copper cone with a 0.24-cm orifice at the bottom and a 100-gram sample.

## Results and Discussion

### Size Segregation

For larger tanks (30.5 m in diameter) with air slide feeding, there is size segregation the degree of which depends on the feeding and discharge configuration. But in all cases, the segregation seems to occur at the low points (or "valleys") between piles of alumina and near the periphery of tanks where alumina particles were subject to least amount of disturbance and where finer particles or dust would settle and accumulate.

Listed in Table I is data for Tank A (12.8 m in diameter, fed by a conveyor belt and sampled at positions given in Figure 2) which did not show any segregation at any sampling points in the single pile. The particle size median was essentially the same everywhere sampled. In contrast, samples from Tank B (30.5 m in diameter and fed by an air slide) did show segregation with the same shipment of alumina as in the case of Tank A. Tank B was sampled twice: once midway of the filling cycle and secondly after the filling was completed. It is noted that valleys and multiple piles formed as a result of the feeding and discharge configuration. Both times, as shown in Table I, significant segregation occurred at the valleys between large and small piles and near the wall, but not on the slope of the piles. The bulk of the material in Tank B had a size median of 95-102 μm; however, portions with a size median as small as 18 μm could be found in the least disturbed low areas. The segregated fines had much higher percentages of -44 μm and -11 μm (39-82% and 16-33%, respectively) compared to the bulk material (9-16% and 2-5%, respectively).

Similar observations, although not as pronounced, were made in Tank C and Tank D at a separate smelting plant. A single pile was present in the smaller Tank C (15-m diameter and belt fed) while two large piles were observed in Tank D (30-m diameter and fed by an air slide). Because Tank D could not be safely entered, no samples could be collected from the "valleys" between piles. For both tanks, two rows of samples were collected along two slopes of the same pile representing two different angles relative to the manhole ladder. As shown in Table II, data from the collected samples (see Figure 3) indicates that practically no segregation was present in Tank C. Segregation of fines, even though not as severe as in Tank B, did exist at the wall in Tank D with the fines having a size median of 83 μm versus 88-91 μm in the bulk. Again, samples

TABLE I. PARTICLE SIZE MEDIANS OF ALUMINA SAMPLES FROM TANK A AND TANK B IN PLANT NO. 1

| Sample Designation | Tank Designation | Distance From Wall (m) | Radial Angle From Manhole (°) | Particle Size Median (µm) | Remark |
|---|---|---|---|---|---|
| A-1 | A | 0 | 0 | 102 | At the manhole ladder |
| A-2 | A | 3.2 | 0 | 100 | |
| A-3 | A | 6.4 | 0 | 101 | At top of the main pile and center of the cross-section. |
| B-1* | B | 0 | 0 | 94.7 | At the manhole ladder. |
| B-2* | B | 3.0 | 0 | 33.5 | At a "valley". |
| B-3* | B | 7.0 | 0 | 100 | |
| B-4* | B | 10.7 | 0 | 99.9 | |
| B-5* | B | 0 | 25 | 17.5 | At the wall. |
| B-6+ | B | 0 | 0 | 73.4 | At the manhole ladder. |
| B-7+ | B | 3.0 | 0 | 97.8 | |
| B-8+ | B | 7.0 | 0 | 102 | |
| B-9+ | B | 10.7 | 0 | 98.5 | |
| B-10+ | B | 1.0 | 25 | 99.3 | At top of a small "ridge". |

NOTE:
*Collected at midway of a filling cycle.
+Collected at end of a filling cycle.

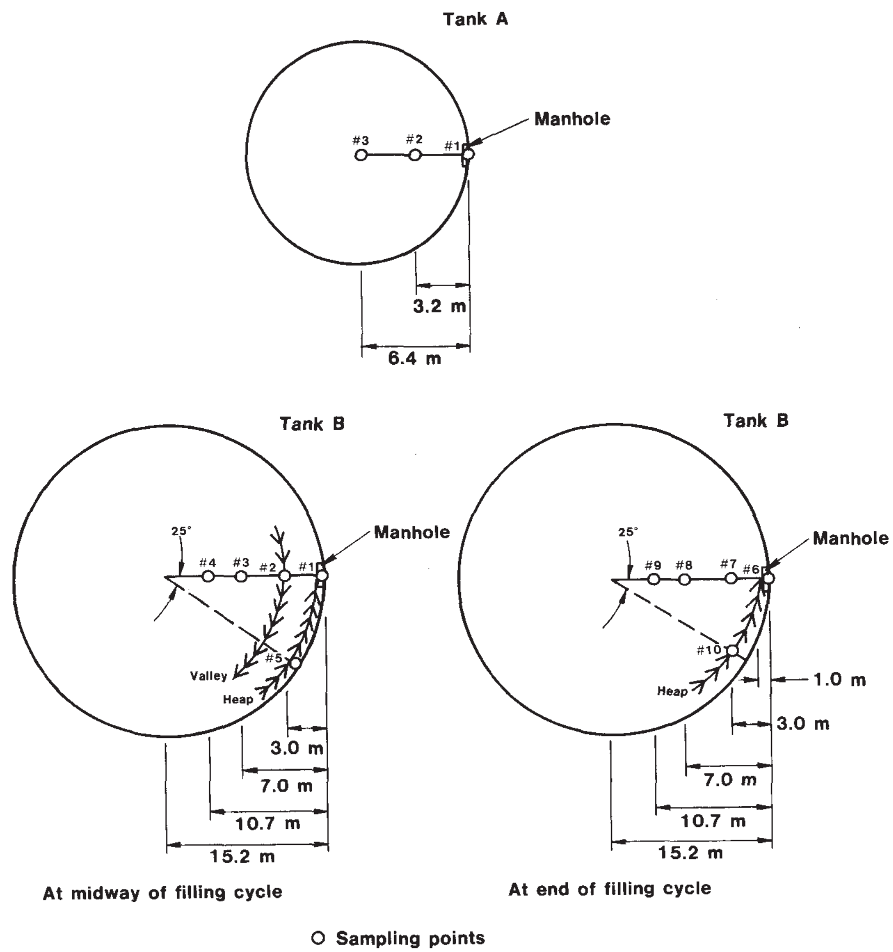


Figure 2 - Sampling positions inside Tank A and Tank B

TABLE II. PARTICLE SIZE MEDIANS OF ALUMINA SAMPLES FROM TANK C AND TANK D IN PLANT NO. 2

| Sample Designation | Tank Designation | Distance From Wall (m) | Radial Angle From Manhole (°) | Particle Size Median (µm) | Remark |
|---|---|---|---|---|---|
| C-1 | C | 0.3 | 0 | 85.1 | Near the wall. |
| C-2 | C | 2.8 | 0 | 86.7 | |
| C-3 | C | 5.8 | 0 | 88.7 | |
| C-4 | C | 7.5 | 0 | 87.2 | Near top of the pile. |
| C-5 | C | 0.3 | 90 | 87.7 | Near the wall. |
| C-6 | C | 2.8 | 90 | 86.8 | |
| C-7 | C | 5.8 | 90 | 89.9 | |
| C-8 | C | 7.5 | 90 | 88.2 | Near top of the pile. |
| D-1 | D | 0.3 | ~25 | 82.9 | Near the wall. |
| D-2 | D | 2.8 | ~25 | 89.0 | |
| D-3 | D | 5.8 | ~25 | 88.3 | |
| D-4 | D | 9.1 | ~25 | 91.3 | |
| D-5 | D | 10.5 | ~25 | 91.0 | At top of a pile. |
| D-6 | D | 0.3 | ~65 | 83.1 | Near the wall. |
| D-7 | D | 2.8 | ~65 | 90.3 | |
| D-8 | D | 5.8 | ~65 | 90.6 | |
| D-9 | D | 9.1 | ~65 | 89.2 | |

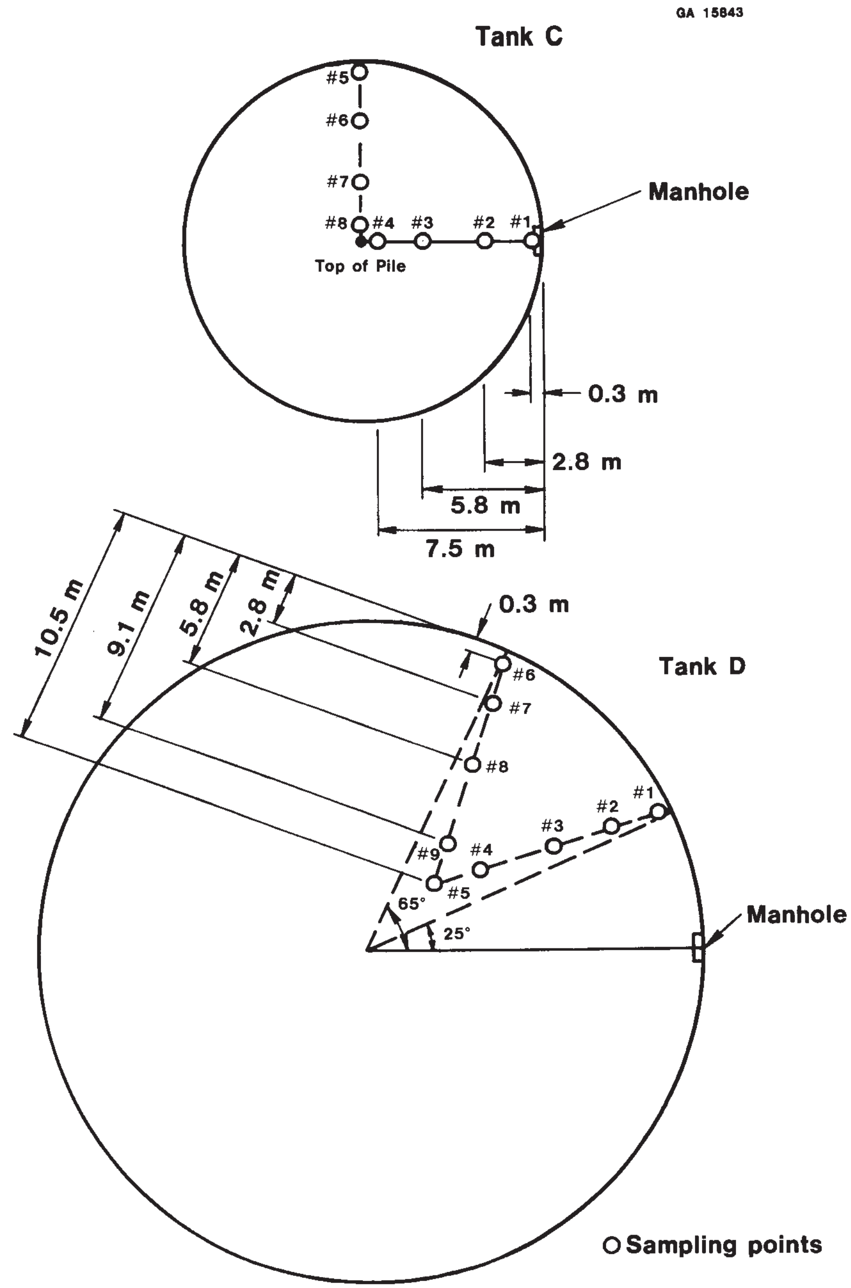


Figure 3 - Sampling positions inside Tank C and Tank D

along the slopes and at the top of piles were approximately the same in size.

The samples described above were collected beneath the pile surface as composite samples in the vertical direction. During sample collection from Tank C and Tank D, samples were also obtained from the pile surface (less than 2 cm deep). The results for Tank D are summarized in Table III. In all cases, the surface samples were finer than the corresponding samples collected beneath the surface. It appears that the finer particles resting on the pile surface after filling is completed can be airborne again and redispersed in the air upon the next vigorous air movement (such as filling) inside the tank. Fines eventually become accumulated in areas that are least disturbed by the air currents in the tank, namely, the wall and the low points between piles.

## Handling Behavior

Quantifying handling behavior is an essential step in solving handling problems and predicting relative handling characteristics of a given material/equipment combination. We have previously studied other alumina samples actually used in smelting plants and compared bench test data with the field responses. A wide variety of samples with "good" or "poor" handleability have been examined. Some results are summarized in Table IV. It is apparent that in general the angle of spatula, compressibility, cohesion and flow funnel time are relatively good indicators for handling characteristics in practice. Particularly the flow funnel time seems to closely relate to the general handleability.

The aforementioned handling properties for the alumina samples collected from Tank A and Tank B are listed in Table V for illustrating the impact of size segregation. The angle of repose data is also included as it is a commonly referenced property, even though not very well related to practical general handleability. The angle of repose for the normal particle size distribution fractions is about 36-38$^{o}$ while for the segregated fines in Tank B it is significantly higher, 43-49$^{o}$. The angle of spatula gives a relative angle of internal friction or angle of rupture for a dry material. Normal particles show an angle of spatula of 42-47$^{o}$ while segregated fines show 53-59$^{o}$. It clearly indicates the poor flowability of segregated fines as they are discharged from the storage tanks.

To determine compressibility, one needs the bulk densities as follows:

$$C = 100\ (P-L)/P \qquad (1)$$

where L and P represent the loose and the packed bulk densities, respectively. The normal bulk particles have a loose and packed bulk density of 0.98-0.99 and 1.19-1.24 g/cm$^3$, respectively. For the segregated fines, the corresponding values are 0.82-0.89 and 1.33-1.41 g/cm$^3$ with the only exception of the slightly segregated sample B-6 from Tank B. The segregated fines have lower air permeability than the normal particles. Consequently once entrapped during handling, air cannot be easily released from the segregated fines, under the low-stress at-rest conditions, thus leading to a lower loose bulk density. When subject to vibration as used in the packed bulk density measurement, the deaerated

TABLE III. COMPARISON OF SURFACE AND COMPOSITE SAMPLES FROM TANK D IN PLANT NO. 2

| Sample Designation | Method of Sampling(1) | Distance from Wall (m) | Radial Angle from Manhole ($^{o}$) | Particle Size Median (μm) |
|---|---|---|---|---|
| D-1S | surface | 0.3 | ~25 | 82.2 |
| D-1 | composite | 0.3 | ~25 | 82.9 |
| D-2S | surface | 2.8 | ~25 | 81.7 |
| D-2 | composite | 2.8 | ~25 | 89.0 |
| D-3S | surface | 5.8 | ~25 | 81.9 |
| D-3 | composite | 5.8 | ~25 | 88.3 |
| D-4S | surface | 9.1 | ~25 | 81.0 |
| D-4 | composite | 9.1 | ~25 | 91.3 |
| D-5S | surface | 10.5 | ~25 | 80.1 |
| D-5 | composite | 10.5 | ~25 | 91.0 |
| D-6S | surface | 0.3 | ~65 | 74.3 |
| D-6 | composite | 0.3 | ~65 | 83.1 |
| D-7S | surface | 2.8 | ~65 | 80.4 |
| D-7 | composite | 2.8 | ~65 | 90.3 |
| D-8S | surface | 5.8 | ~65 | 84.5 |
| D-8 | composite | 5.8 | ~65 | 90.6 |
| D-9S | surface | 9.1 | ~65 | 80.9 |
| D-9 | composite | 9.1 | ~65 | 89.2 |

NOTE:

(1) Surface: sample collected less than 2 cm deep from surface.
Composite: sample collected as a composite over a distance of 0.9 m below surface.

TABLE V. BULK HANDLING PROPERTIES OF SEGREGATED ALUMINA FRACTIONS IN TANK A AND TANK B

| Sample Designation | Size Median (μm) | Angle of Repose (°) | Angle of Spatula (°) | Loose Bulk Density ($g/cm^3$) | Packed Bulk Density ($g/cm^3$) | Compressibility (%) | Cohesion (%) | Flow(1) Funnel Time (min.) |
|---|---|---|---|---|---|---|---|---|
| A-1 | 102 | 36 | 43 | 0.99 | 1.20 | 17.5 | 16.8 | 5.2 |
| A-2 | 100 | 37 | 42 | 0.99 | 1.19 | 16.8 | 16.2 | 4.5 |
| A-3 | 101 | 37 | 42 | 0.98 | 1.19 | 17.6 | 19.5 | 4.7 |
| B-8 | 102 | 37 | 43 | 0.99 | 1.20 | 17.5 | 24.0 | 5.2 |
| B-3 | 100 | 37 | 47 | 0.99 | 1.21 | 18.2 | 21.3 | 6.7 |
| B-4 | 100 | 38 | 46 | 0.99 | 1.21 | 18.2 | 24.5 | 6.3 |
| B-10 | 99.3 | 38 | 46 | 0.99 | 1.24 | 20.0 | 16.4 | 7.5 |
| B-9 | 98.5 | 38 | 44 | 0.99 | 1.21 | 18.0 | 23.1 | 6.0 |
| B-7 | 97.8 | 37 | 47 | 0.99 | 1.21 | 18.0 | 18.8 | 6.1 |
| B-1 | 94.7 | 40 | 51 | 0.99 | 1.24 | 20.2 | 21.5 | 8.6 |
| B-6 | 73.4 | 43 | 53 | 0.99 | 1.33 | 26.0 | 25.8 | * |
| B-2 | 33.5 | 48 | 54 | 0.89 | 1.40 | 36.0 | 44.4 | * |
| B-5 | 17.5 | 47 | 57 | 0.82 | 1.35 | 39.3 | 42.0 | * |

NOTE: (1)*flow funnel time indicating that sample would not flow through the funnel.

TABLE IV. COMPARISON OF ALUMINA HANDLING PROPERTIES BY BENCH TESTS AND BY FIELD RESPONSES

| Sample No. | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 |
|---|---|---|---|---|---|---|---|---|
| Handling Characteristics(1) | good | good | good | good | good | poor | poor | poor |
| Angle of Repose (°) | 37 | 31 | 35 | 32 | 35 | 39 | 36 | 41 |
| Angle of Fall (°) | 21 | 18 | 21 | 16 | 20 | 21 | 23 | 26 |
| Angle of Difference (°) | 16 | 13 | 14 | 16 | 15 | 18 | 13 | 15 |
| Angle of Spatula (°) | 45 | 43 | 46 | 39 | 37 | 46 | 47 | 52 |
| Loose Bulk Density ($g/cm^3$) | 1.05 | 1.02 | 1.04 | 1.02 | 1.01 | 1.02 | 0.97 | 1.03 |
| Packed Bulk Density ($g/cm^3$) | 1.30 | 1.24 | 1.25 | 1.20 | 1.19 | 1.31 | 1.19 | 1.30 |
| Compressibility (%) | 19.2 | 17.7 | 16.8 | 15.0 | 15.1 | 22.1 | 18.2 | 20.3 |
| Cohesion (%) | 18 | 14 | 10 | 5 | 4 | 34 | 15 | 20 |
| Flow Funnel Time (min.) | 5.6 | 5.2 | 7.2 | 4.4 | 4.5 | 13.5 | 8.1 | 12.4 |
| Attrition Index (%) | 14 | 12 | 11 | 19 | 14 | 9 | 14 | 13 |

NOTE:

(1) Field responses (remarks made by smelting personnel).

segregated fines achieve a higher packed bulk density due to better particle packing than the normal bulk particles. Packing volume fraction has been calculated from the particle size distribution data for the samples according to a mechanical packing model proposed by Lee (4). Table VI shows that the segregated fines have higher values of packing volume fraction than normal bulk particles, thus having higher packed bulk densities.

It has been suggested that when the compressibility is above 20%, the material would not be free-flowing. Particularly, when the compressibility is close to 40% or higher, it becomes very difficult to discharge the material from a hopper once the material has been stored in it for an extended period of time. The normal particles have a compressibility of 17-20% while the segregated fines have 26-39% as indicated in Table V.

The cohesion is a direct measurement of the amount of energy required to pull apart aggregates of cohesive particles in a specified time. A powder has less flowability when it has a high cohesion. Segregated fines have a cohesion greater than 25%, while normal bulk particles have a lower value (Table V).

The flow funnel test provides a simple and quick method of accessing the relative flow property of a powder, particularly suitable for implementation in the field. It is apparent from Table V that all the segregated fines smaller than 75 μm in size median would not flow through the funnel and the normal bulk particles flow through in less than 7.5 minutes.

## Chemical Properties

Most of the samples collected from Tank A and Tank B were analyzed for LOI, water adsorption at 44% relative humidity, alpha-alumina and impurities. The impurity of particular interest and significantly different between the segregated fractions is silica. As apparent from Table VII, the segregated fines have appreciably higher values of LOI, water adsorption, alpha-alumina and silica. This was confirmed in a separate, more detailed study by analyzing ten narrow cut fractions (ranging from 4 to 127 μm in size median) prepared from a given batch of alumina. The surface area was found in that study to increase with the size median as a result of lower amounts of alpha-alumina at higher size medians.

## Proposed Segregation Mechanisms in Alumina Storage Tanks

Fine particles move about in a storage tank as a result of the motion of the air in which they are suspended particularly during filling. Basically there are three modes of air motion inside a storage tank that can disperse the material: pulvation, secondary air currents by induction and through exhaust or openings (5). Pulvation occurs when a mass of falling alumina strikes existing piles in the tank, thus suddenly compacting the loose bulk material with a violent escape of air which carries fine particles with it by the shearing force. The fine particles then become airborne. The pulvation in this case is multi-directional.

TABLE VI. PACKED BULK DENSITY AND CALCULATED PACKING VOLUME FRACTION OF ALUMINA SAMPLES FROM TANK A AND TANK B

| Sample Designation | Packed Bulk Density ($g/cm^3$) | Packing Volume Fraction |
|---|---|---|
| A-1 | 1.20 | 0.701 |
| A-2 | 1.19 | 0.696 |
| A-3 | 1.19 | 0.695 |
| B-1 | 1.24 | 0.726 |
| B-2 | 1.40 | 0.778 |
| B-3 | 1.21 | 0.712 |
| B-4 | 1.21 | 0.718 |
| B-5 | 1.35 | 0.739 |
| B-6 | 1.33 | 0.778 |
| B-7 | 1.21 | 0.717 |
| B-8 | 1.20 | 0.700 |
| B-9 | 1.21 | 0.689 |
| B-10 | 1.24 | 0.716 |

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TABLE VII. CHEMICAL CHARACTERISTICS OF SEGREGATED ALUMINA FRACTIONS IN TANK A AND TANK B

| Sample Designation | Size Median (µm) | LOI (%)(1) | Water Adsorption(2) (%) | $\alpha$-$Al_2O_3$ (%) | $SiO_2$ (%) |
|---|---|---|---|---|---|
| A-1 | 102 | 0.61 | 2.89 | 7.3 | 0.018 |
| A-3 | 101 | 0.56 | 2.93 | 7.2 | 0.018 |
| B-1 | 94.7 | 0.57 | 2.97 | 8.5 | 0.018 |
| B-2 | 33.5 | 0.89 | 4.01 | 23 | 0.021 |
| B-4 | 100 | 0.64 | 2.97 | 8.4 | 0.017 |
| B-5 | 17.5 | 0.91 | 4.17 | 27 | 0.021 |
| B-6 | 73.4 | 0.71 | 3.32 | 14 | 0.018 |
| B-10 | 99.3 | 0.62 | 2.94 | 8.4 | 0.017 |

NOTE:

(1) Loss on ignition (300-1200°C)
(2) Water adsorption at 44% relative humidity.

Induction occurs when a mass of alumina falls with each particle imparting some momentum to the surrounding air. This results in the induction of an air stream along with the alumina. The induced air flow moves some fine particles away from the column of alumina into the air inside the storage tank. Secondary air currents can also come from exhaust or openings. Both secondary air flows, by induction and through exhaust or openings, transport the localized dusty air, mostly formed by pulvation, away from the site of formation.

It appears from the field data that many airborne fine particles, carried around by the aforementioned secondary air currents, settle and accumulate in areas subject to least disturbance from air currents during filling, namely the areas near the periphery of a tank or "valleys" between piles. When filling or discharging stops, the remaining airborne fine particles will fall on the pile surface rather uniformly. Some of these fine particles may sift through voids between coarse particles and the remaining fine particles on the surface can become airborne again when there is sufficient air current inside the tank. Therefore fine particles may keep accumulating and concentrating in sizable zones, particularly near the wall. When the withdrawal from the tank is sufficient to include these peripheral and "valley" zones, slugs of fines are in the discharge.

As stated earlier, a potentially primary driving force for size segregation in a storage tank is the air currents inside. The secondary air currents carry the airborne particles away from the center into outer areas. To illustrate the significance of induced air flow in affecting the air movement and consequently the size segregation of alumina in a storage tank, an estimate was made based on a realistic set of conditions for Tank B: 120 t/hr alumina feed rate, filling cross section of 0.29 $m^2$ and a distance of fall of 10 m. According to an equation developed by Hemeon (5), the rate of the induced air flow for particles falling at terminal velocity is given by

$$q = 16.57 \sqrt[3]{R\,(\Delta S)A^2} \qquad (2)$$

where q = induced air flow, $m^3$/min.
R = solid feed rate, t/hr
A = cross-sectional area of stream of particles, $m^2$
$\Delta S$ = distance of fall by particles, m

The calculated induced air flow for Tank B under the conditions specified above is 77 $m^3$/min. (or 4620 $m^3$/hr). The rate thus calculated tends to be high when compared with field data due to the underlying assumptions. Nevertheless, the calculated result can serve as a good indication. The fact that the calculated induced air flow can be about an order of magnitude higher than other combined air flows through the storage tank illustrates the importance of induced air flow.

A comparison of the magnitude of induced air flow rate was made between Tank A and Tank B in Plant No. 1. A typical set of conditions for Tank A is: 120 t/hr alumina feed rate, filling cross section of 0.073 $m^2$ and a distance of fall of 7 m. Applying Equation (2) results in a calculated induced air flow of 27 $m^3$/min. which is only about 1/3 of that for Tank B. This may partially explain why segregation occurred in Tank B but not in Tank A.

Another potentially important factor affecting size segregation is the mode of filling the storage tank. In a separate study, it was observed that air slide feeding has the tendency to separate the fine particles from the coarser ones even before the alumina particles reach the storage tank. The easy-to-separate particles, once transferred into the tank from the air slide, can easily segregate into fractions under the influence of primary pulvation and secondary air currents, especially the latter. In contrast, feeding the storage tanks by conveyor belt does not appear to promote particle separation. A more definitive study of the relative effects of air slide feeding and secondary air current (such as induced air flow) on size segregation in an alumina storage tank is planned to be conducted under controlled conditions in a pilot scale test using a given size tank.

Three of the four tanks cited in this study have single-entry feeding and one uses a splitter to generate two feeding streams. One approach to reduce size segregation is changing the storage system configuration. Well known methods in this category include multiple-entry feeding (2), multiple discharge points, use of a cone under the entry point to spread the particles more evenly to various positions, the use of an internal spreader pipe, placing a cone-shaped obstruction above the discharge orifice, the use of baffles, etc. Another approach is changing the particle size distribution of the alumina.

## Conclusions

Size segregation of alumina particles in storage tanks has been widely known to exist but not been explored in a systematic fashion. This study analyzed the problem by collecting field samples from inside tanks of various configurations and characterizing the samples for important handling properties. Two case studies were made and, in both cases, segregation occurred in large tanks (30 m in diameter) with air slide feeding but not in smaller tanks (12.8-15 m in diameter) with conveyor belt feeding. Segregated fines were formed in "valleys" between piles and at the periphery of the tank while samples collected at other points along the slopes of piles had normal particle size distribution. The segregated fractions exhibited markedly different handling properties such as angles of flow (repose and spatula), compressibility, cohesion and flow funnel time. The fines had appreciably higher values of LOI, water adsorption, alpha-alumina and silica. The field data appears to indicate that fine alumina particles are separated from the bulk when an air slide is used to feed to the storage tanks. As the alumina feed strikes existing piles in a tank, pulvation makes the fine particles become airborne. Secondary air currents, particularly the induced air flow caused by the falling streams of alumina, carry the fines away from the pulvation sites. Fine particles can eventually settle and accumulate in areas subject to least disturbance from air currents, namely the areas near the periphery of a tank or "valleys" between piles. A more definitive study of the relative effects of air slide feeding and secondary air flow on size segregation in an alumina storage tank is needed and will be conducted under controlled conditions using a given size tank.

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