Upgrade of Existing Cell Feeding Systems

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Abstract

The Material Distribution Systems are fully automated systems. Once installed and well commissioned they are sometimes forgotten and their influence on the process is overlooked. But there are definitely influences on the reduction process from the feeding system. As all plants worldwide have to watch out for optimization potentials, a deeper look into the Material Distribution System is worthwhile. Not only could there be a potential to optimize maintenance cost, the distribution system may as well have an influence on the material itself. This is the topic of this paper. At first the preconditions for this task are reviewed. Based on this, several laboratory investigations on alumina and other powders has been undertaken to evaluate options for the ideal Material Distribution System and as well for upgrades of existing Material Distribution Systems.

Keywords: Cell feeding system, material handling, energy efficiency, conversion of cell feeding system.

1. Introduction

Smelters are in operation for several decades. Capacities of the potlines are increased during this time. The auxiliary equipment like the material distribution equipment is sometimes a limitation for the process or has to be upgraded as capacity is increased. But there might be other issues, which effect the decision for an upgrade or a modification of an existing distribution system. The conveying process could as well have an effect on the material properties and there will be a feedback to the conveying and the smelting process. Attrition or segregation are examples, to name only some of them. In this article, the different effects that varying parameter will have on the behavior of the material are highlighted. To verify these effects extensive tests with several materials have been performed, references [1, 2, and 6]. For the particle sizes present in the alumina industry, the very fine fraction is often the fraction responsible for flow problems. So if looking at a mixture of materials, the question is, how much poorly-flowing fine material, e.g. from particle attrition and fracture, can a free-flowing coarse material tolerate without any significant change in its flow characteristics?

The first part of the investigation has already been presented in [1] and will only be summarized briefly. The second part of the investigation was the wear behaviour of the material and fluidization tests. In a next step the different criteria for a decision for upgrade or modification of a conveying and distribution system are highlighted. In the third step, some option for modifications are introduced.

2. Theoretical Considerations

The flow behavior of bulk materials is essentially determined by the adhesive forces acting between the individual particles in relation to the external forces acting on the mass of bulk material. This means that the respective packing structure of each mixture, i.e., compacted, loosely packed, fluidized, etc., influences the behavior of the mixture. Mixtures of two dry, spherical monoparticulate fractions with a particle diameter ratio of $R_d = (d_{S,f} / d_{S,g}) \rightarrow 0$, $d_{S,f}$ = diameter of fine particles, $d_{S,g}$ = diameter of coarse (gross) particles, are in theory easy to describe and are used as a model for the bulk material mixtures consisting of a very fine and a coarse fraction which are examined here. A more comprehensive approach is given in [2].

The mixtures are characterized by their mass share of fine material, x_f :

$$x_f = \frac{M_{S,f}}{M_{S,f} + M_{S,g}} \tag{1}$$

If an increasing quantity of fine material with a relative void volume of ε_f is mixed into a coarse material with a relative void volume of ε_g then the free space between the coarse particles is initially filled by the fine material without causing any increase in the total volume $V = V_s + V_g$ of the mixture, where V_s is the volume of solids and V_g is the volume of the gas in the voids. As the voids are filled, the packing density of the solid material increases and the relative void volume of the mixture ε_M decreases. When the available volume between the particles of coarse material is completely filled up, any further addition of fine material will lead to an enlargement of the particle structure, i.e., the relative void volume of the mixture ε_M increases again. These interrelationships are depicted in Figure 1 for loosely packed coarse ash/fly ash mixtures with ε_g = 0.5054, coarse ash, and ε_f = 0.6708, fly ash (compare [1 - 3, 5 - 7]).

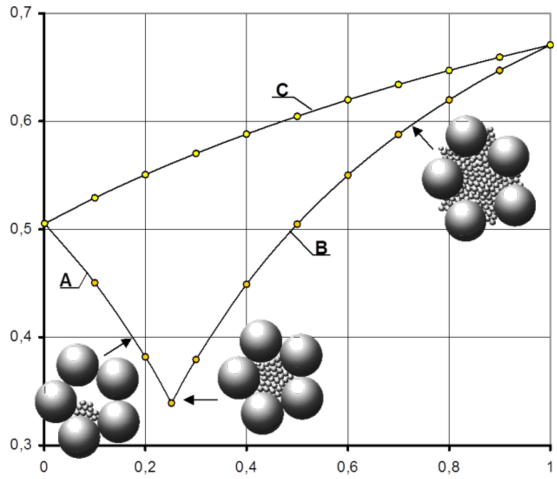

Figure 1. Relationship between relative voidage volume (vertical axis) and relative fines content (horizontal axis) [2, 5]. Relative volume is defined with respect to total volume.

For the case analyzed here, $R_d \rightarrow 0$, the two lower curves A and B apply. All the ε_M values of dual-particle mixtures, consisting of spherical or approximately spherical particles, are located between the three limiting curves A-B-C.

An analysis of the structure of the coarse particle fraction shows that its void volume consists of larger voids between the coarse particles and narrower connecting channels between these voids (compare [2], [8]). Without causing any expansion of the structure, only fine material particles with a maximum diameter of $d_{S,FK}$ (filler particles) can fit into the interparticle voids. In the case of practical, i.e. unstructured, dual- particle mixtures above grain size ratios of

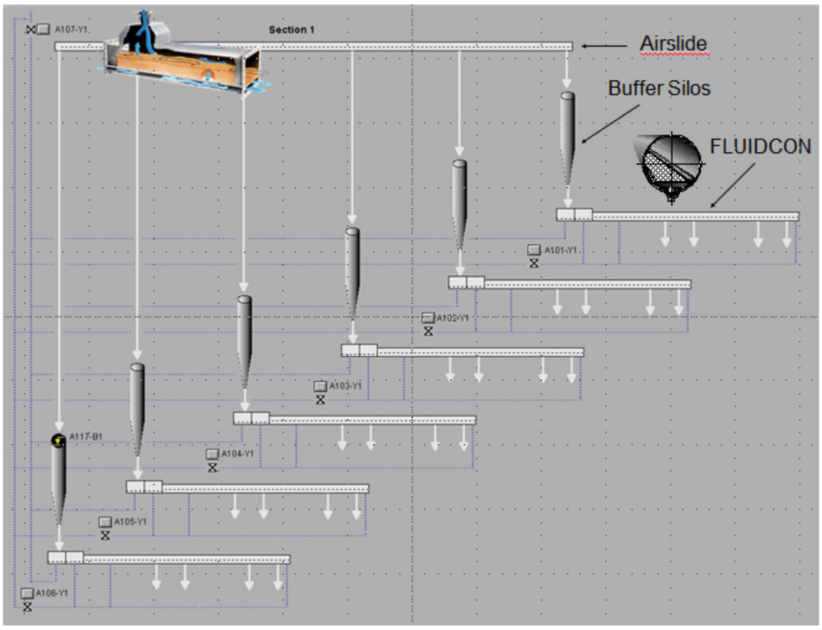

Figure 11. Example of a hybrid FCF-System.

Several factors might influence the decision how to proceed forward. Restrictions regarding dimension or regarding air consumption will influence the actual condition. So every case must be evaluated in detail.

6. Outlook

Several laboratory investigations have been made to evaluate influencing factors of particle size distribution and material behaviour of alumina. Target was to assess the effects, that changes in the conveying parameter will have on a system already installed and to determine the magnitude of these effects. The fine fraction will always create the most headache and the generation of fines has to be avoided or reduced. Looking at upgrades of existing installation, a Hybrid FCF-system will be advantageous. But only a detailed calculation from case to case will give clear answers.

7. References

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