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Original Research Paper

Experimental study about the agglomeration behavior in slurry prepared by adding excess polyelectrolyte dispersant

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ABSTRACT

In our previous paper we found that the particles in the slurry can agglomerate by adding larger amount of polyelectrolyte dispersant compared to that needed to attain well dispersion. Thus, the dependency of initial particle concentration on the agglomeration and its mechanism in slurry prepared by adding excess polyelectrolytes was experimentally discussed. It was shown that agglomeration behavior strongly depends on the additive amount of polyelectrolytes, not on the polyelectrolyte concentration in the solution. It was also found that the dominant factor of agglomeration in slurry prepared by adding extra polyelectrolytes should be the compression of the electrical double layer by the increased counter ion concentration, not by the so called depletion effect or by pH change. Interestingly, the final sediment had a relatively high packing fraction and good flowability in the case of the agglomerated slurry with extra polyelectrolytes compared to that of the agglomerated slurry with an additional NaCl solution.

1. Introduction

Slurries are widely used in various industrial processes such as ceramics wet shaping, spray-drying, solid–liquid separation and waste water treatment. It is very important to appropriately control the particle dispersion and flocculation state in slurries since a desirable state is varied in each process [1–4]. In an aqueous system, the particle dispersion and flocculation state can be changed by changing the slurry pH and/or adding some additives such as dispersants and flocculants. In the case of adding polyelectrolytes for slurry preparation, it is well known that the particle assembling state in the slurry changes as a network flocculated, well-dispersed, and an agglomerated state, by increasing the additive amount [5–11]. In general the particle settling velocity is lower and the packing fraction of the final sediment is higher for the well-dispersed slurry compared to the flocculated slurry in gravitational settling tests. However, in our previous reports, we have reported that both the settling velocity and the packing fraction of sediment of agglomerated slurries are higher than those of well-dispersed slurries [7,11]. In addition, it was also reported that the packing fraction of pressure filtered cake formed from agglomerated slurry is almost the same or higher than that of well-dispersed slurry [12].

If we can take advantage of the above unique features of agglomerated slurry, improvements in the effectiveness of the slurry processes should be possible. For example, a dense green body can be quickly obtained from slip casting in ceramics or a dense (low water content) cake can be quickly obtained from filtration in solid–liquid separation. Therefore, we believe that agglomerated slurry prepared by adding excess polyelectrolytes is a very interesting research topic having great potential for application to real industries.

Usually, dense slurries are used in the ceramic fabrication process, while the particle concentration of slurries in waste water treatment is very dilute. Thus, it is necessary to clarify the effect of particle concentration in slurry on the agglomeration behavior in practice. The objective of this study was to obtain a guideline to prepare the above agglomerated slurry in a wide range of particle concentrations. The agglomeration mechanism in the slurry prepared by adding excess polyelectrolytes is experimentally discussed as well.

2. Experimental procedure

2.1. Slurry preparation

Slurries were prepared from alumina powder (AES-11E, average particle size = 0.48 μm, density = 3960 kg m^{-3}, specific surface area = 6.74 m^2 g^{-1}, Sumitomo Chemical, Japan) and distilled water. One of the typical anionic polyelectrolytes, an ammonium salt of polycarboxylate (CELUNA D-305, Mw = 6000–10,000, Chukyo

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