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Flocculation of precipitated calcium carbonate (PCC) by cationic tapioca starch with different charge densities. II: Population balance modeling

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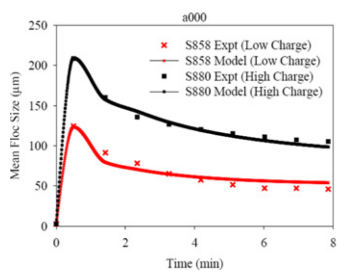
HIGHLIGHTS

- ▶ PCC flocculation was modeled by employing population balance equation.
- ▶ High charge starch resulted in lower collision efficiency and restructure rate.
- ▶ Stronger floc was produced by high charge density starch.
- ▶ Collision efficiency decreased with the increase of the shear rate.

GRAPHICAL ABSTRACT

Population balance model provides an excellent agreement between the experimentally observed evolution of the mean floc size with time with the model-based calculated values.



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ABSTRACT

A population balance model to describe the flocculation of PCC by two cationic tapioca starches is presented. The model takes into account aggregation, floc breakage and floc restructure. Floc strength as indicated by energy dissipation rate was also evaluated. It was found that the high charge density starch relates to lower collision efficiency, lower restructure rate and higher floc strength (higher energy dissipation rate) compared to the case with the low charge density starch. Lower energy dissipation rate was needed to break the flocs at higher temperature for both starches. On the other hand, the high charge starch was more likely to be negatively affected by the background electrolyte NaCl. The collision efficiency decreased with the increase of the shear rate for both starches. The difference of charge, starch morphology on PCC surface and the charge suppression effect were employed to interpret the results.

1. Introduction

In order to understand, predict and control the flocculation of precipitated calcium carbonate (PCC), it is necessary to develop quantitative models which are able to describe aggregation and breakage under various processing conditions. Since the pioneering efforts of Smoluchowski in the early 20th century [1], population balance model has been used widely for modeling the kinetics of granulation [2–4], nucleation [5–8], crystallization [6,9], sintering [10–12], and flocculation [13–18]. Traditionally, population balance model is one-dimensional which takes size as the only floc property and assumes the floc structure stable throughout the flocculation process [19,20]. Ding et al. [21] presented a population balance model of activated sludge flocculation and extracted the aggregation rate and selection rate constants through fitting the model to the experimental data without the consideration of the floc structure evolution. Biggs and Lant [22] assumed the activated

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