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Flocculation of precipitated calcium carbonate (PCC) by cationic tapioca starch with different charge densities. I: Experimental

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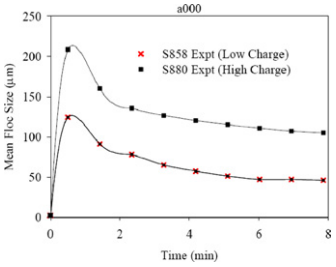
HIGHLIGHTS

- The PCC floc size went through a maximum before reaching steady state.
- Larger and more compact flocs were produced by higher charge density starch.
- The mass fractal dimension of the flocs continued increasing as flocculation proceeds.
- The high charge starch was negatively affected more by background electrolyte.
- PCC surface charge decay for S858 and S880 system was observed.

GRAPHICAL ABSTRACT

High charge density starch S880 resulted in larger flocs compared to those produced by low charge density starch S858.



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ABSTRACT

The dynamics of the flocculation of precipitated calcium carbonate (PCC) with two commercial cationic tapioca starches (S858 and S880) with different charge densities were studied by small angle static light scattering. The effects of temperature, polymer dosage, ionic strength, and shear rate on the floc size and structure were investigated by employing a response surface methodology involving the central composite statistical design and analysis of variance (ANOVA). The evolution of floc size and structure was observed and it was found that larger and more compact flocs were produced by the high charge density starch S880. The floc's mass fractal dimension indicates the floc's compactness and it was found that the compactness increases as the flocculation proceeds. The ionic strength plays a significant role on the floc size with S880. Finally, the negative effect of shear rate on floc size was more pronounced for the low charge density starch S858.

1. Introduction

The pre-flocculation of precipitated calcium carbonate (PCC) before adding it to a wood fibre suspension in the papermaking process improves the retention of the PCC particles and thus contribute towards manufacturing highly filled paper. Highly filled paper is a more profitable and more sustainable papermaking practice [1–3].

The PCC floc size and its structure and strength are important process parameters. Gaudreault et al. [4] employed static light scattering/diffraction, photometric dispersion analysis and microscopy imaging to study the structure and strength of PCC flocs formed by four polymers including cationic potato starch. Cationic potato starch was found to flocculate PCC fast and create PCC aggregates with size less sensitive to dosage at dosages less than 0.5 mg/g of PCC. Particles size equals to 18 μm was reached at a starch dosage of 7 mg/g.

Modgi et al. [5] reported that the adsorption of a potato starch with a degree of substitution (DS) of 0.034 on PCC was greater than that of a potato starch with DS = 0.1. The investigation of PCC

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