

The Contribution of Particle Swelling and Coalescence to Gel Layer Formation in Mixed HPMC and Partially Pregelatinized Starch Matrices

INTRODUCTION

To visualize the swelling behavior and coalescence of hypromellose (HPMC) and partially pregelatinized starch particles to monitor the contribution to gel layer formation in mixed HPMC and Starch 1500®, partially pregelatinized maize starch, matrices.

MATERIALS

- HPMC USP type 2208 (METHOCEL™, premium cellulose ethers, K4M) and partially pregelatinized starch (Starch 1500), both 90-125 µm sieve fraction.
- 0.003M Coomassie Blue in 0.9% Sodium Chloride solution was used to hydrate the particles.

METHODS

The behavior of hydrating HPMC and Starch 1500 particles was visualized by transmitted light microscopy with automated image acquisition and manual analysis (Image Pro Plus v4.5, Media Cybernetics, UK). Particles were hydrated on the Microscope Slide Positioning System (MSPS), which separates two microscope slides by an accurately measured, user-defined distance. Particles hydrated between these slides swell in the radial dimension, and images were captured digitally. The swelling behavior and coalescence of the single and mixed particle population were monitored with respect to time.

RESULTS

HPMC

HPMC particles show extensive and uniform swelling, which, on boundary contact (Figure 1), coalesce to form a continuous gel matrix. (Figure 2)

Figure 1. Diagrammatic Representation of HPMC Particle Coalescence

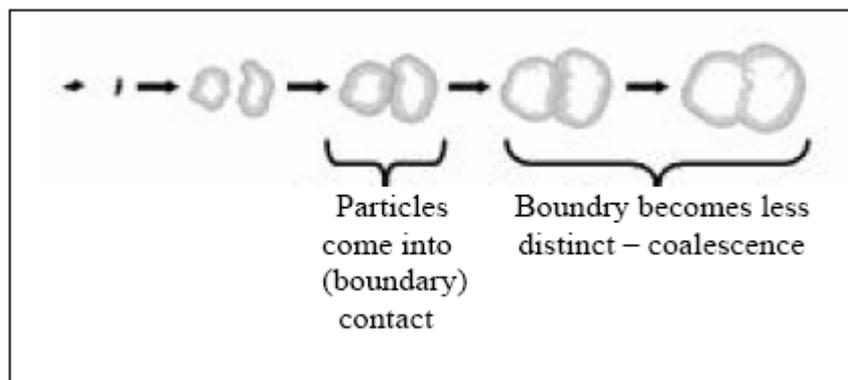
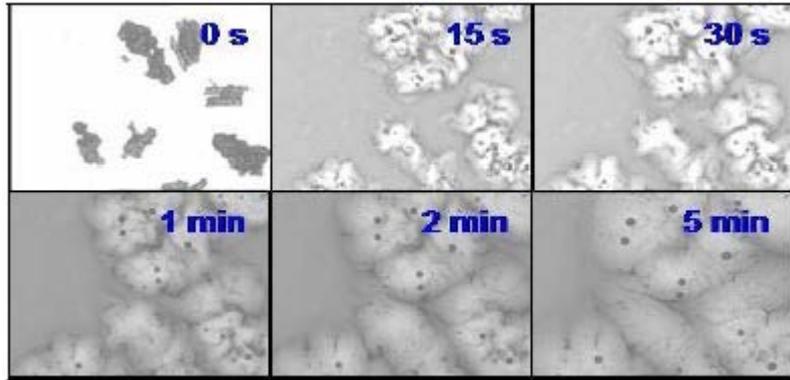


Figure 2. HPMC Particle Swelling and Coalescence



Starch 1500

Starch 1500 particles show complex hydration behavior (Figure 3) with 3 distinct population types (Figure 4);

(B1) Particles which swell, developing a transparent appearance with well-defined edges

(B2) Composite particles which display an initial burst of swelling but remain well defined.

(B3) Particles which become poorly defined, with extensive swelling and dissolution, but which retain gel volume within the mixed polymer gel.

Figure 3. Starch 1500 Particle Swelling and Coalescence

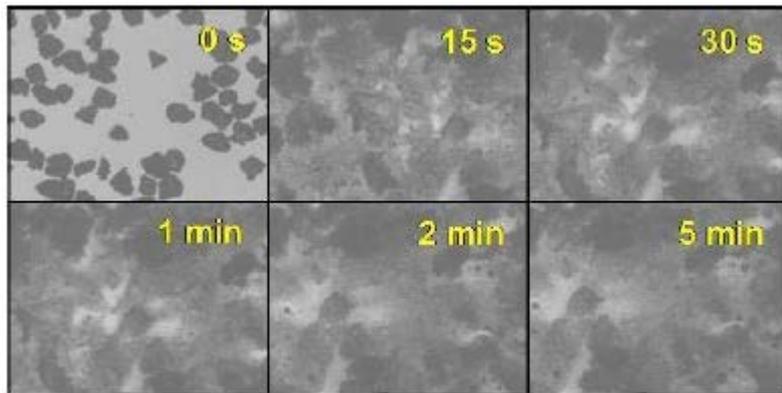
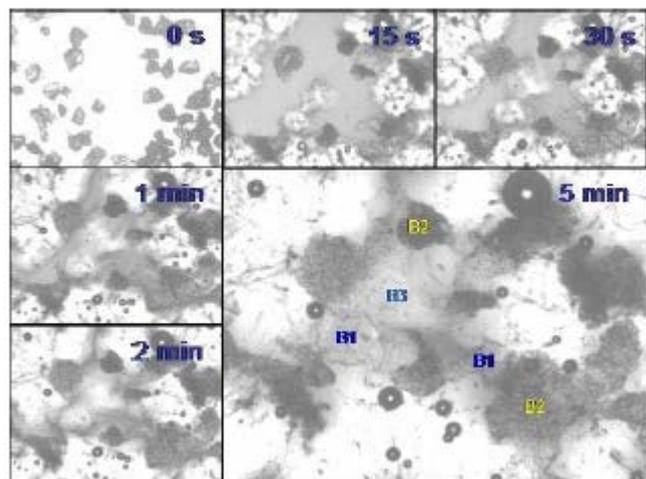


Figure 4. HPMC and Starch 1500 Particle Swelling and Coalescence.

Examples of Starch Swelling Types are Labelled (see text)



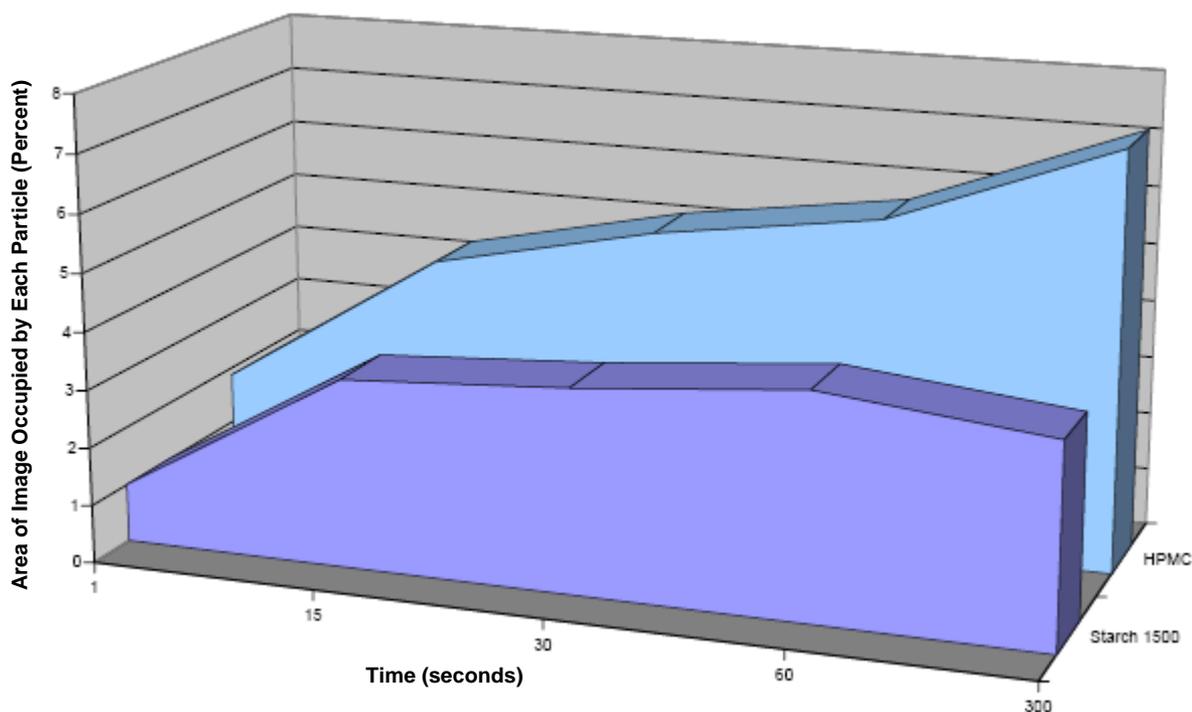
Mixed HPMC & Starch 1500 Populations

- The mixed gel consisted of starch domains enclosed within a swollen HPMC continuum.
- Each type of hydration behavior contributed to the overall morphology of the mixed gel.
- The relative size of HPMC and starch domains is shown in Figure 5.

Several coalescence mechanisms were seen:

- HPMC showed clear coalescence where boundaries met.
- Starch domains remained separate and mixed with HPMC only at dilute outer edges.
- The swollen HPMC enveloped the starch and, in some cases, compacted the starch domain.

Figure 5. Particle Growth in Mixed Populations with Respect to Hydration Time



CONCLUSIONS

The mixed population of HPMC and Starch 1500 particles hydrated to form a phase separated gel. Starch 1500 exhibited 3 visually different types of swelling and hydration behavior.

Coalescence occurred between HPMC particles, but not significantly between starch and HPMC.

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