In-line characterization of a whey protein aggregation process: aggregates size and rheological measurements

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The growing consumer demand for foods with specific nutritional and functional attributes prompts the industry to review products formulation. Consequently, heat induced whey proteins (WP) are widely used as ingredients in elaborated foods for their functional properties. The aggregates functionalities strongly depend on the aggregates size, which is largely affected by the time-temperature-shear rate history. The latter also affects the rheological properties and consequently the flow behavior, which directly influences the aggregates size distribution (ASD).

The purpose of this work was to select and implement on a microparticulation process in-situ sensors to monitor and control WP aggregation. Conventional granulometric and rheologic methods need sampling which could damage the aggregates and introduce systematic errors. In-situ measurements provide quick assessment of the impact of process variables on the ASD and viscosity.

Focused beam reflectance measurement (FBRM), an innovative in-situ method of particles counting and sizing, was used for ASD assessments. A tube viscometer was designed and constructed to perform in-line rheological measurements. Experiments were investigated on a heat treatment pilot plant with WP solutions of 6% $\beta$-lg added with different concentrations of CaCl$_2$. Three different holding temperatures allowing WP aggregation were explored.

Results obtained show significant variations of measured data with operating conditions. Aggregates mean sizes and viscosity data increase with the holding temperature and the CaCl$_2$ concentration as expected. A good correlation was found between viscosity data and aggregates mean sizes. FBRM and tube viscometer are shown to be valuable tools to perform in-line characterization of heat induced WP aggregation process.