Aseptic Processing of a Strawberry Pulp in a Continuous Ohmic Heater: Numerical Simulations and Model Validation

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Continuous food-sterilization processes often involve the flow of liquids or solid-liquid mixtures, frequently highly viscous and with non-Newtonian behaviour, in pipes and reactors. Heat treatment of such flows is complex and it is necessary to guarantee that each part of the material is adequately processed, preventing overcooking as much as possible. The use of ohmic heating technology as an alternative heating method has regained interest for complex fluids or multiphase foods.

In this work the residence time distributions (RTD) of an industrial strawberry pulp (with non-Newtonian rheology) continuously processed in a pilot scale ohmic heater were numerically simulated using a computational fluid dynamic (CFD) software (Fluent Inc., New York, USA). The rheology of the strawberry pulp was experimentally determined and included in the CFD flow model. The validation of the simulated RTD was made by creating a negative step input using a strawberry pulp with a different pH value and monitoring the pH variation at the inlet and outlet of the continuous ohmic heater.
The determination of the RTD exclusively in the heating zone allowed the prediction of the residence time of each pulp fraction. Based on this information as well as on previously obtained data on electrical conductivity and its dependency on temperature ($\sigma = m \cdot T + b$) it was possible to estimate the temperature of the fluid at the end of the heating zone (T_f) using the equation:

$$T_f = \frac{(mT_i + b)\exp\left(\frac{m|\Delta V|^2}{c_p}\tau\right) - b}{m}$$

The temperature at the outlet of the heater was monitored for the different flow rates and compared with the simulated results in order to validate this equation.

The use of this continuous ohmic heater to efficiently pasteurize strawberry pulps is possible if using voltages higher than 100 V and flow rates lower than 2.0 kg/min. To operate at higher flow rates it will be necessary either to increase the electrical conductivity of the strawberry pulp by adding salts or other ionic constituents or the power of the heater.