Analysis and model-based optimization of a pectin extraction process

Raw material quality disparity is an unavoidable and systemic variability in the solid-liquid extraction process of pectin manufacturing. A mathematical model is considered for a robust optimization of the process, taking into the account raw material quality uncertainty, for two different scenarios of pectin product quality profiles. Before application, the model is evaluated through local sensitivity analysis. Raw material-specific parameters and non-significant parameters are removed from the parameter set targeted for identification. Furthermore, it is shown that the model outputs are highly sensitive to the peel specific parameters, which inherently vary from peel-to-peel. This impact was further assessed through an uncertainty analysis, which quantified the variability of model predictions due to the raw material parameter uncertainty for three different types of fruit. The model exhibits a good general depiction of the extraction phenomena. Major operating variables, i.e., temperature, pH and batch time, are optimized in a deterministic manner for each fruit to maximize the final pectin concentration while satisfying given requirements. Based on this, a robust optimization strategy is examined to design an optimal operation strategy in consideration of the inherent uncertainty of feedstock and the desired product quality.