Modelling of jet cleaning of processing plants a data driven approach

FRYER P. (1), BAKALIS S. (2), LOPEZ-QUIROGA E. (1), TUCK J. (1)
1 University of Birmingham, Birmingham, United Kingdom
2 University of Copenhagen, Copenhagen, Denmark

Most food processing plants are fitted with Cleaning-in-place (CIP) systems that use sprays/jets to clean vessels. The efficiency of these sprays/jets depends on a combination of processing parameters such as deposit thickness, nozzle diameter and sprays/jet flow rates. This work explores the suitability of using data-driven modelling techniques - i.e., Response Surface Modelling (RSM) and Machine Learning (ML) - to map and optimise such jet cleaning processes (RSM), as well as to predict their corresponding cleaning curves (ML).

A series of jet cleaning experiments of a viscoplastic deposit were designed to collect data and characterise the effect of (i) jet flow rate (ii) nozzle diameter and (iii) deposit thickness on cleaned areas (cm2) over time (up to 60 seconds) at both lab and pilot plant scale.

Results showed that for the system under study:
(i) surface response models can be used to map and optimise operating conditions for the jet- cleaning of a viscoplastic deposit, revealing those combinations of flow rate, nozzle size and deposit thickness that had potential to maximise cleaned area at the end of the cleaning process.
(ii) Artificial Neural Networks (ANN) can predict the dynamics of the cleaning process - this is cleaned areas at the observed times - from the test data set with accuracy (RMSE = 1.50). This method also provided a good of the cleaned areas values and cleaning curve trends at unseen times (time intervals not included in the training nor test sets).

Overall, this work presents a first approach to the use of data-driven techniques to model jet impinging CIP processes. Results revealed potential in using such approaches as the core of digital/virtual tools that help designing, monitoring and optimising hygienic processing conditions in the food industry.