Process Design and Optimization for Sustainable Thermal Heating: application to Ohmic Heating

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Many enabling technologies of Industry 4.0 contribute to the creation of so called Digital Twin, i.e. the virtual twin of a physical process that using mathematical models is able to describe the process, product or service in a precise way in order to carry out preliminary analysis and apply process control strategies. Digital Twin models often integrate software based on artificial intelligence, machine learning and data analytics using data collected from production facilities to create digital simulation models that update themselves in relation to the change in the parameters of the production processes. It is a self-learning mechanism, which makes use of data collected from various sources such as sensors that transmit operating conditions or supplemented by knowledge integrated by human resources.
In the food sector, the possibility of predicting, for example, the effects of heat treatments using different technologies according to the degree of food safety required in terms of abatement of microbial CFU is an extremely important objective.
In the present work a Digital Twin model will be presented for systems based on Ohmic heating in which the learning part of the system is also developed on the basis of mathematical models, through which the thermal effects of the electric field on the product are obtained using information on the cold points of the system coming from numerical simulations.
The information is then analyzed through artificial intelligence systems for the development of a reverse model able to indicate the electrical power required as a function of the maximum programmed operating temperatures, number of log reduction and electrical conductivity of the product.