ICR0020

MODELING OF TURBULENT FLOW AND HEAT TRANSFER DURING REFRIGERATION OF STACKED FOOD PRODUCTS

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Proposed technical session : 6 Refrigeration for preserving the quality and enhancing the safety of foods. (Mathematical modeling and computer simulation of heat transfer)

Cooling of stacked products such as fruits or vegetables in a wind tunnel often shows strong heterogeneities of thermal treatment. Some products located in dead zones are not sufficiently cooled while others exposed to high velocities can be desiccated. A poor temperature management of the products may lead to their deterioration or even their loss. The heterogeneity of treatment is first due to the heating of the air as it crosses the products and second to the variations of the heat transfer coefficient between the air and the surface of the products. The second aspect concerns especially non-uniform airflows.

A model is presented which predicts airflow and heat transfer in stacked food products considered as a porous media. There are few studies in the literature in which local heat transfer intensity is related to the local mean velocity magnitude. The presented model takes additionally into account the turbulence intensity. An original one-equation model is used to predict the local turbulent kinetic energy.

Experiments were carried out with stacked spheres in a two-dimensional configuration where airflow is deviated by baffles. Good agreement is observed between thermal predictions and experimental results. The model predicts especially a preferential pathway on which higher heat transfer intensity is observed and inversely dead zones (in the corners) were the heat exchanges are the lowest. Finally, heat transfer enhances when penetrating in the stack, this is due to increase of turbulence intensity.