CFD modeling of airflow and temperature distribution in a smokehouse

BARRETO CONCEPCION I. (1), HELDMAN D. (1)
1 The Ohio State University, Columbus, United States

An industrial smokehouse is a forced-air convection chamber used to smoke and cook food products. Smoking has been practiced for centuries as a food preservation method. The smoking process consists of three phases: condensation of water on the surface, the adsorption of smoke elements on the surface, and drying the surface. These phases are governed by the heat and mass transfer rate both inside the product and at the interface between the air and the product surface. The heat and mass transfer rate are influenced by the air temperature, relative humidity, inlet vent air velocity, smoke density, and airflow uniformity within the smokehouse.
The typical ventilation system of smokehouses significantly influences airflow and temperature distributions within the chamber. These parameters, in turn, directly impact the product quality attributes and process efficiency. The overall objective of this study was to develop a 3D Computational Fluid Dynamics (CFD) model to study the effect of smokehouse ventilation system configuration on airflow uniformity. The model was validated with experimental results from the prototype smokehouse (3.15 m x 1.69 m x 2.94 m). Results include detailed analysis on the effect of ventilation system configuration on air velocity, air temperature, and average surface heat transfer coefficient and temperature of a meat analog. The CFD model can be used as an effective tool to design and evaluate new vent configurations to improve airflow uniformity in smokehouses.