# ABSTRACT

Baking is a complex and energy-intensive process that involves numerous chemical, physical, and biological reactions that take place simultaneously. In a baking oven, radiation heat transfer is the most prevalent mode of heat exchange. In the present investigation, a new baking oven was designed with two hemicylindrical domes (called reflectors) attached to the heating coils at the top and bottom of the baking oven. Firstly, view factors were computed by finite element and analytical methods with different bread dimensions, as well as with and without the reflectors. The network representative method (NRM) and Surface to Surface (S2S) method were employed to analyse the radiation energy transfer in the oven at different baking temperatures using the same bread sizes. The results obtained from numerical and analytical methods were fairly similar. The radiative heat energy absorbed by bread surface was higher with the reflector than without the reflector in the oven. As the number of obstructions increased, the radiative heat flux was reduced. The use of reflector shield in oven affect the heat flux arrived on the bread. The radiative heat flux received by bread was found to have increased on increasing the oven temperatures. The radiative heat flux received by bread top surface was greater with reflector elements than without reflector element. The average heat flux received by the bread top surface with reflector was 4 to 5% and 2 to3% greater than without reflector for bread heights of 9 and 5 cm, respectively at various oven temperatures. The radiation energy was reduced by 20 to 29% using a partitioned oven with reflector.

In addition, the energy was evaluated using the inverse heat transfer method based on the heat flux approach. The 2D unsteady state standard heat transfer problem was solved in COMSOL Multiphysics. The unknown boundary heat flux was estimated on the top and bottom surface of the boundary using the inverse heat transfer technique with optimization of a modified Levenberg-Marquardt (LM) algorithm that included a complex variable differentiation method (CVDM). The energy demand for 9 cm of bread in an oven with a reflector was estimated to be 180.76, 202.43, and 196.78 kJ for oven temperatures of 180, 200, and 220 °C, respectively. Similarly, the energy requirement of 5 cm of bread in oven with reflector was found to be as 127.86, 122.38 and 121.90 kJ for oven set temperature of 180, 200, and 220 °C, respectively. The specific energy consumption (kJ/kg) of bread was higher for 5 cm of bread at a temperature of 180 °C and lower for temperature of 200, and 220 °C. The obtained simulated transient temperature was in good agreement with the experimental temperature data. The use of a reflector element and higher baking temperatures allowed for faster browning of the bread's surface. The crust thickness of bread was found to be greater with the reflector (4.56 ± 0.13 to 5.06 ± 0.11 mm) than without the reflector (2.97 ± 0.1 to 4.16 ± 0.1 mm).



***Keywords:*** *View Factor, Radiative Heat Transfer, Obstruction, Heat Flux, Inverse Heat Transfer, Energy Estimation, Colour*