Abstract

A need exists to monitor and control the localized high temperatures often experienced in solar grain dryers, which result in grain cracking, reduced germination and loss of cooking quality. A verified finite element model would be a useful to monitor and control the drying process. This study examined the feasibility of the finite element method (FEM) to predict temperature distribution in solar grain dryers. To achieve this, an indirect solar grain dryer system was developed. It consisted of a solar collector, plenum and drying chambers, and an electric fan. The system was used to acquire the necessary input and output data for the finite element model. The input data comprised ambient and plenum chamber temperatures, prevailing wind velocities, thermal conductivities of air, grain and dryer wall, and node locations in the xy-plane. The outputs were temperature at the different nodes, and these were compared with measured values. The ${\pm}5%$ residual error interval employed in the analysis yielded an overall prediction performance level of 83.3% for temperature distribution in the dryer. Satisfactory prediction levels were also attained for the lateral (61.5-96.2%) and vertical (73.1-92.3%) directions of grain drying. These results demonstrate that it is feasible to use a two-dimensional (2-D) finite element model to predict temperature distribution in a grain solar dryer. Consequently, the method offers considerable advantage over experimental approaches as it reduces time requirements and the need for expensive measuring equipment, and it also yields relatively accurate results.