Title Simulation of Transport Phenomena during Natural Convection Cooling of Bagged Potatoes in Cold Storage, Part I: Fluid Flow and Heat Transfer

Author M.K. Chourasia and T.K. Goswami

Citation Biosystems Engineering, Volume 94, Issue 1 , May 2006, Pages 33-45

Keywords potato; phenomena; heat transfer

Abstract

Agricultural produce, such as potato, onion, *etc*. are packed in permeable gunny bags for cooling in a natural convective environment and subsequent long-term storage. Due to permeable boundaries, the heat and mass transfer within the bag is strongly affected by the flow characteristics, especially during the transient cooling process. Therefore, an attempt was made in this study to simulate the three-dimensional airflow and heat transfer in this system using the computational fluid dynamics technique. The mass transfer phenomenon is being modelled in Part II of this paper. It was found that air mainly penetrated through bottom and side surfaces of the bag and escaped from top surface. The velocity contours maintained symmetry about both the horizontal axes in horizontal plane and only about the vertical axis in the vertical plane. The same patterns were observed for isotherms as well. The average natural convective velocity in the bag at steady state was found to be 0·0016 m s^{-1}. The temperature of the product in the bag decreased at a very fast rate during the initial cooling period and then dropped to comparatively slow rates. In the vertical plane, the zone of maximum temperature was observed below the top surface of the bag at the early stages of cooling and it proceeded towards the centre point as the cooling progressed. Steady-state average temperature in the bag was found to be 0·13 K higher than the surrounding air temperature at 274 K. The experimental product temperature at the centre of the bag was found to be higher than that of the simulated one. The maximum and minimum temperature deviation from the experimental values were 3·4 K at 287·1 K and 0·5 K at 279·1 K on 2nd and 16th day of cooling respectively when the measured initial and final temperatures of potato at the centre were 297·1 and 278·1 K, respectively for a total cooling period of 25 days.