

Effect of Shrinkage on Heat and Mass Transfer Parameters of Solar Dried Potato Samples of Variable Diameter

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Abstract : Potato is chosen as the food product for carrying out the natural convection mixed-mode solar drying experiments since they are easily available and globally consumed. The convective heat and mass transfer coefficients along with effective diffusivity were calculated considering both shrinkage and without shrinkage for the potato cylinders of different geometry (8, 10 and 13 mm diameters and a constant length of 50 mm). The convective heat transfer coefficient (h_c) without considering shrinkage effect were 24.28, 18.69, 15.89 $W/m^2\text{ }^\circ C$ and h_c considering shrinkage effect were 37.81, 29.21, 25.72 $W/m^2\text{ }^\circ C$ for 8, 10 and 13 mm diameter samples respectively. Similarly, the effective diffusivity ($Deff$) without considering shrinkage effect were 3.20×10^{-9} , 4.82×10^{-9} , 2.48×10^{-8} m^2/s and $Deff$ considering shrinkage effect were 1.68×10^{-9} , 2.56×10^{-9} , 1.34×10^{-8} m^2/s for 8, 10 and 13 mm diameter samples respectively and the mass transfer coefficient (h_m) without considering the shrinkage effect were 5.16×10^{-7} , 2.93×10^{-7} , 2.59×10^{-7} m/s and h_m considering shrinkage effect were 3.71×10^{-7} , 2.04×10^{-7} , 1.80×10^{-7} m/s for 8, 10 and 13 mm diameter samples respectively. Increased values of h_c were obtained by considering shrinkage effect in all diameter samples because shrinkage results in decreasing diameter with time achieving in enhanced rate of water loss. The average values of $Deff$ determined without considering the shrinkage effect were found to be almost double that with shrinkage effect. The reduction in h_m values is due to the fact that with increasing sample diameter, the exposed surface area per unit mass decreases, resulting in a slower moisture removal. It is worth noting that considering shrinkage effect led to overestimation of h_c values in the range of 55.72-61.86% and neglecting the shrinkage effect in the mass transfer analysis, the values of $Deff$ and h_m are overestimated in the range of 85.02-90.27% and 39.11-45.11%, respectively, for the range of sample diameter investigated in the present study.

Keywords : shrinkage, convective heat transfer coefficient, effective diffusivity, convective mass transfer coefficient

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