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Modelling Water Vapor Sorption and Diffusion in Hydrocolloid Particles

Authors : Andrew Terhemen Tyowua, Zhibing Zhang, Michael J. Adams

Abstract : Water vapor sorption data at a range of temperatures (25–70 °C) have been obtained for starch (corn and wheat) and non-starch (carrageenan and xanthan gum) hydrocolloid particles in the form of a thin slab. The results reveal that the data may be more accurately described by an existing sigmoidal rather than a Fickian model. The sigmoidal model accounts for the initial surface sorption before the onset of bulk diffusion. At relatively small water activities (≤ 0.3), the absorption of the moisture caused the particles to be plasticized, but at greater activity values (> 0.3), anti-plasticization was induced. However, it was found that for the whole range of water activities and temperatures studied, the data could be characterized by a single non-dimensional number, which was termed the non-Fickian diffusion number where τ is the characteristic time of surface sorption, D is the bulk diffusion coefficient and L is the thickness of the layer of particles. The activation energy suggested that the anti-plasticization mechanism was the result of a reduction in the molecular free volume or an increase in crystallinity.

Keywords : anti-plasticization, arrhenius behavior, diffusion coefficient, hygroscopic polymers, moisture migration, non-fickian sigmoidal model
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