ABSTRACT

Using appropriate hydrothermal treatment the input materials, namely, parboiled polished rice, parboiled brown rice and parboiled paddy were prepared and the relevant physical properties for mathematical modelling and accelerated tempering vessel design were determined. A laboratory model accelerated tempering vessel having provisions for monitoring the completion of tempering based on relative humidity of the overhead space, vacuum control and quick loading and unloading of grains was designed and fabricated. Drying characteristics of the input materials were determined using fluidised bed drying at different air temperatures. In double-pass drying of parboiled paddy, tempering characteristics were determined at different levels of applied vacuum after drying the grains in the first-pass upto the estimated critical moisture content. Mathematical models to simulate drying of different input materials and tempering of parboiled paddy were developed based on isothermal liquid diffusion in multi-component prolate spheroid geometry using prolate spheroidal co-ordinate system and finite difference solution methodology. The liquid diffusion coefficients of parboiled paddy components during drying and diffusivity factor during tempering of parboiled paddy were determined by minimising the sum of squared deviation between experimentally observed and model predicted characteristics. The developed models showed good agreement with the experimentally observed data and the effects of various model parameters on the model performance were also studied. The model simulation outputs included the drying and tempering characteristics of whole grains and their components, moisture profile in the grain during drying and tempering, second-pass and total double-pass drying characteristics of parboiled paddy. Paddy tempered under vacuum and atmospheric conditions exhibited similar second-pass drying characteristics. Maximum reduction of 72 % in total processing time could be achieved in accelerated tempering with 700 mm of Hg vacuum gauge against conventional tempering. Temperature dependence of liquid diffusion coefficients was expressed using Arrhenius type of equation and the effect of vacuum on the diffusivity factor was expressed with an exponential equation.

Key words

Accelerated tempering, Diffusion coefficient, Drying, Finite difference, Mathematical modelling, Multi-component, Parboiled paddy, Prolate spheroid, Prolate Spheroidal co-ordinate system