Title Paddy dehydration by adsorption: Thermo-physical properties and diffusion model of agriculture residues

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Abstract

Dehydration of high-moisture grain kernels using adsorption is an interesting method, especially when agricultural residues are used as adsorbents. This dehydration method is a low-temperature drying process that is simple, requires no mechanical equipment, has low energy consumption and maintains grain quality. The aim of this research was to investigate the use of rice husk, coconut husk and sago palm rachis to reduce the moisture content of fresh paddy. The thermo-physical properties and the drying kinetics of these agricultural residues acting as moisture adsorbents were studied. The bulk density, specific heat capacity, void fraction, equilibrium moisture content (EMC) and the effective diffusion coefficient (D_{eff}) of the adsorbents were determined. The bulk density, specific heat capacity and void fraction were determined at initial moistures contents ranging from 4.1% to 72.4% dry-basis (d.b.). The EMC and D_{eff} values were measured at surrounding temperatures and relative humidity varying from of 40 to 70 °C and from 10% to 90%, respectively. For evaluating the D_{eff} value using thin-layer drying (TLD), an experiment was carried out at inlet air temperatures of 30–70 °C. The bulk density and specific heat capacity of all three adsorbents were linearly dependent on the moisture content and the void fraction was inversely related to the moisture content. The four commonly cited EMC equations were fitted to the experimental data. A modified Henderson equation provided the best fit for describing the EMC isotherm of all the study cases. The modified Henderson and Pabis model provided a good fit to the experimental TLD results and the D_{eff} values, determined by non-linear regression, were significantly affected by the inlet drying air temperature. The D_{eff} values were in the range 1.2×10^{-8}–6.2×10^{-8} $m^2 s^{-1}$. Sago palm rachis had the highest D_{eff} value compared to coconut husk and rice husk. However, the most suitable adsorbent material was rice husk because it was easy to prepare and it could be regenerated by low-temperature heating.