Part 2

Drying model

(Azmir et al., 2018) modelled the energy balance for drying particles, which is given by the governing equation:

$$m_i c_{p,i} \frac{dT_i}{dt} = q_{i,dry}, \tag{1}$$

where $c_{p,i}$, and T_i are the specific heat capacity (J/kg/K) and temperature (K) of particle *i*. The heat of evaporation $q_{i,dry}$ (J/s) for particle *i* is presented as a function of moisture content of the particle:

$$q_{i,dry} = h_{fg}\left[1 + a\exp\left(bY_{i,H_2o}\right)\right]S_{i,H_2o}. \tag{2}$$

where Y_{i,H_2o} is the dimensionless mass fraction of moisture content (liquid mass divided by solid mass of particle *i*), S_{i,H_2o} is the drying rate of moisture content (kg/s), and h_{fg} is the latent heat of vaporisation of free water (J/kg). The dimensionless coefficients *a* and *b* are 3.2 and 21.7 for the grains (corn kernel) in (Azmir et al., 2018). However, these coefficients should be determined for the materials (polypropylene) used in our simulations.
The mass fraction of moisture content is governed by the following equation:

$$m_i \frac{dY_{i,H_2o}}{dt} = S_{i,H_2o}, \tag{3}$$

where the drying rate of moisture content S_{i,H_2o} (kg/s) is defined as:

$$S_{i,H_2o} = -h_m A\left[\rho_{v,s} - \rho_{v,\infty}\right], \tag{4}$$

where $\rho_{v,s}$ and $\rho_{v,\infty}$ are the vapor concentrations at the particle-medium interface and in the drying medium (kg/m^3), respectively. h_m is the mass transfer rate (m/s), and *A* is the surface area of the particle (m^2).
$\rho_{v,s}$ can be obtained from the saturation vapor concentration $\rho_{v,sat}$ (kg/m^3) using the following equation:

$$\rho_{v,s} = \exp\left(-\frac{\Delta E_v}{RT}\right)\rho_{v,sat}(T_s), \tag{5}$$

where ΔE_v is the relative activation energy of evaporation (J), and *T* is the temperature of the particle (K). ΔE_v can be described by the following equation:

$$\Delta E_v = \Delta E_{v,b} f(Y - Y_b), \tag{6}$$

where $\Delta E_{v,b} = -RT_b \ln(RH_b)$, and $f(Y - Y_b)$ is a function of the difference in the moisture content. RH_b is the relative humidity of drying air, Y_b is the equilibrium moisture content under the condition of drying air (kg/kg), and T_b is the drying air temperature (K).
(Keey, 1992) calculated saturated vapor concentration (kg/m$^{3)}$ at the surface temperature T_s ($\rho_{v,sat}(T_s)$) for the range of temperature 0-200 centigrade, given by:

$$\rho_{v,sat}(T_s) = 4.844 * 10^{-9}(T_s - 273)^{4} - 1.4807 * 10^{-7}(T_s - 273)^{3} + 2.657 * 10^{-5}(T_s - 273)^{2} - 4.8613 * 10^{-5}(T_s - 273) + 8.342 * 10^{-3}. \tag{7}$$