1-D transient heat conduction model for cooking meat

Mather Chefs

November 2019

1 Heat Transfer Model

The non-dimensional governing equation is given by:

$$\frac{\partial \theta}{\partial Fo} = \frac{\partial^2 \theta}{\partial \eta^2} \tag{1}$$

Correspondingly for our case the initial condition and the boundary conditions are:

$$\begin{aligned} \theta(\eta, 0) =& 1 \\ \frac{\partial \theta}{\partial \eta}\Big|_{(1,Fo)} =& Bi\theta(1, Fo) \\ \theta(0, Fo) =& 0 \end{aligned} \tag{2}$$

General solution to the heat conduction equation with the given boundary conditions is given by:

$$\begin{aligned} \theta(\eta, Fo) =& \sum_{n=1}^{\infty} A_n \exp(-\lambda_n^2 Fo) cos(\lambda_n \eta) \\ A_n =& \frac{2 \sin \lambda_n}{\lambda_n - \sin \lambda_n \cos \lambda_n} \end{aligned} \tag{3}$$

Here the Eigen values, λ_n, are the roots to the following transcendental equation and are given by:

$$\lambda_n \tan \lambda_n = Bi \tag{4}$$