New Problems Chapter 20

20.1-7. ***Diffusion through a solid using Fick's second law.*** Determine the carburizing time necessary to achieve a carbon concentration of 0.5% at a position 2.5 mm into an iron–carbon alloy that initially contains 0.10% C. The surface concentration is to be maintained at 1.5% C, and the treatment is to be conducted at 1000°C with a $D_{AB} = 6.2\times10^{-11}\,\frac{m^2}{s}$. Use Fick's second law to solve the equation:

$$\frac{C_x - C_0}{C_s - C_0} = 1 - erf\left(\frac{x}{2\sqrt{D_{AB}t}}\right)$$

20.1-8. ***Diffusion in a solid using Table 20.1.1.*** Walmart is doing a study on the shelf life of Italian sausage (cylindrical) in its super market. Their sausages are 2in in diameter and 6in long and the case is at 10°C. Initially the sausage has a liquid moisture content of 0.001M, but sitting in the meat case it is exposed air with a concentration of water $C_w = 4.30\frac{mole}{m^3}$ The equilibrium constant between the air and the sausage is K = 1.5 and assume $D_{AB} = 1\times10^{-5}\,\frac{cm^2}{s}$ and $k = \infty$. . How long (hours) will it take for the center of the sausage to reach 2.12 times its initial concentration.

20.2-2. ***Unsteady-State Diffusion and Reaction.*** Solute A is diffusing at unsteady state into a semi-infinite medium of pure B and undergoes a 1st order reaction with B. Solute A is dilute. How long will it take for the concentration C_A = .2M at z =0.4mm? Physical Property data are $D_{AB} = 1\times10^{-9}\,\frac{m^2}{s},\ k' = 1\times10^{-4}\,\frac{1}{s},\ C_{A0} = 1M.$

20.3-4. ***Unsteady-State Diffusion and Reaction (COMSOL).*** A flat slab of wood, with a height of 100 mm and a width of 50 mm, contains $3\frac{mole}{m^3}$ moisture is being dried from both sides (ends are insulated). The equilibrium moisture content at the surface of the wood due to the drying air is held at a $0.1\frac{mole}{m^3}$ moisture content. If $D_{AB} = 1.033\times10^{-9}\,\frac{m^2}{s}$ how long will it take the center to reach a $1\frac{mole}{m^3}$ moisture content.