New Problems Chapter 14

14.2-4. ***Unsteady-State conduction with Low Biot Number.*** A Cast iron cylinder $\left(k = 30\frac{BTU}{hr \cdot ft \cdot {}^{\circ}F}\right)$ 0.8 in diameter and 3ft long is annealed by heating to 1800R and then slowly cooling to 675R in an air environment for which T_∞ = 585R and $h = 3.5\frac{BTU}{hr \cdot ft^2 \cdot {}^{\circ}F}$. Estimate the time required (min) for the cooling process

14.3-13 ***Unsteady-State Conduction with negligible surface resistance.*** A flat plate of polystyrene board $\left(k = 0.04\frac{W}{m \cdot K}, Cp = 0.15\frac{kJ}{kg \cdot K}\right)$ 1.5m thick is initially at 350K and then it is dropped in a cooling bath at T_∞ = 280K with an outside convection of $h = 100\frac{W}{m^2 \cdot K}$. Estimate the final temperature at the center of the polystyrene board after 60 min, using equation 14.3-6.

14.3-13 ***Unsteady-State Conduction with negligible surface resistance.*** A flat plate of polystyrene board $\left(k = 0.04\frac{W}{m \cdot K}, Cp = 0.15\frac{kJ}{kg \cdot K}\right)$ 1.5m thick is initially at 350K and then it is dropped in a cooling bath at T_∞ = 280K with an outside convection of $h = 100\frac{W}{m^2 \cdot K}$. Estimate the final temperature at the center of the polystyrene board after 60 min, using equation 14.3-6.

14.3-14 ***Unsteady-State Conduction in a Cylinder with a moderate Biot number.*** A long cylinder of 30mm diameter, initially at a uniform temperature of 1000K, is suddenly quenched in a large oil bath at 375K. The cylinder properties are $k = 1.7\frac{W}{m \cdot K}, Cp = 1600\frac{J}{kg \cdot K}, \rho = 400\frac{kg}{m^3}$, while the convection coefficient is $h = 56.68\frac{W}{m^2 \cdot K}$. Calculate the time required for the surface of the cylinder to reach 500K.

14.3-15 ***Unsteady-State Conduction in a Sphere with a moderate Biot number.*** A sphere with a 180mm diameter, is initially at a uniform temperature of 1200K, is suddenly quenched in a large oil bath at 400K. The sphere properties are $k = 1.7\frac{W}{m \cdot K}, Cp = 1600\frac{J}{kg \cdot K}, \rho = 400\frac{kg}{m^3}$, while the convection coefficient is $h = 18.89\frac{W}{m^2 \cdot K}$. Calculate the temperature of the center of the sphere after 30min.

14.5-6 ***Thawing a slab of meat***. Slabs of meat 2.5 in thick are to be thawed in a refrigerator at 279K. The meat is initially at a frozen temperature of 250K. The meat contains 68% moisture. Physical properties are $\rho = 1000\frac{kg}{m^3}, k = 0.4\frac{W}{m \cdot K}, \Delta H_m = 335\frac{kJ}{kg}$, and $h = 17\frac{W}{m^2 \cdot K}$. Calculate the time needed to thaw the meet.