

(5) Assumed carton dimensions:-

$$86 \text{ mm} \times 295 \text{ mm} \times 410 \text{ mm}$$

$$R = 0.043 \text{ m} \quad A = 0.086 \times 0.295 = 0.02537 \text{ m}^2$$

$$V = 0.086 \times 0.295 \times 0.410 = 0.01040 \text{ m}^3$$

$$A = \pi R^2 \beta_1$$

$$\beta_1 = 0.02537 / (\pi \times 0.043^2)$$

$$= 4.37$$

$$V = \frac{4}{3} \pi R^3 \beta_1 \beta_2$$

$$\beta_2 = 0.01040 / \left(\frac{4\pi}{3} \times 0.043^3 \times 4.37 \right) = 7.14$$

With these shape ratios the E value will be close to 1.0. However to calculate it Bi and hence h_e must be known. Guess $v = 3 \text{ m/s}$.

$$h_a = 7.3 (3)^{0.8} = 17.6 \text{ W/m}^2\text{K}$$

$$\frac{1}{h_e} = \frac{1}{17.6} + \frac{0.0028}{0.062} = 0.102 \text{ K/W}$$

$$h_e = 9.8 \text{ W/m}^2\text{K}$$

$$Bi = 9.8 \times 0.043 / 1.59 = 0.265$$

$$E = 1 + \left(1 + \frac{2}{0.265} \right) / \left(4.37^2 + \frac{2 \times 4.37}{0.265} \right) + \left(1 + \frac{2}{0.265} \right) / \left(7.14^2 + \frac{2 \times 7.14}{0.256} \right)$$

$$= 1 + 0.164 + 0.080 = 1.24$$

$$\theta_{fm} = 1.8 + 0.263(-20) + 0.105(-38) = -7.5^\circ\text{C}$$

$$\Delta\theta_1 = (8 + -7.5) / 2 - -38 = 38.3 \text{ K}$$

$$\Delta\theta_2 = -7.5 - -38 = 30.5 \text{ K}$$

$$\Delta H_1 = 3.5 \times 10^6 (8 - -7.5) = 54.3 \times 10^6 \text{ J/m}^3$$