

10.K Use of Transpiration to Reduce Heat Losses.

(1) Without transpiration:

$$Q_r = -4\pi k r^2 \frac{dT}{dr}$$

Integrating over the shell thickness we get:

$$Q_r = +4\pi k (T_2 - T_1) / \left(\frac{1}{r_2} - \frac{1}{r_1} \right)$$

$$= 4\pi (0.02) (30 + 362) / \left(\frac{1}{1} - \frac{1}{0.5} \right)$$

$$-Q_r = 99 \text{ Btu hr}^{-1}$$

(2) With transpiration:

From Eq. 10.5-30:

$$Q_r = 4\pi k R_0 (T_1 - T_\infty) / \left(e^{(R_0/kR)(1-\kappa)} - 1 \right)$$

From an energy balance:

$$-Q_r = w_p \lambda = 4\pi k \lambda R_0 / \hat{C}_p$$

We now combine these two expressions and rearrange the result to obtain:

$$\begin{aligned} -Q_r &= \frac{\kappa R}{(1-\kappa)} \left(\frac{4\pi k \lambda}{\hat{C}_p} \right) \ln \left[\frac{(T_1 - T_\infty) \hat{C}_p}{\lambda} + 1 \right] \\ &= \left(\frac{0.5 \times 1}{0.5} \right) \left(\frac{4\pi \times 0.02 \times 91.7}{0.22} \right) \ln \left[\frac{(392)(0.22)}{91.7} + 1 \right] \\ &= 69.5 \text{ Btu hr}^{-1} \end{aligned}$$

10.L Frictionless Processes in an Ideal Gas.

a. Substituting $\hat{C}_p = p\hat{V}/T$ for $\hat{C}_v$ we may write:

$$p \hat{C}_p (\underline{v} \cdot \nabla T) = k \nabla^2 T - p(\nabla \cdot \underline{v}) + \frac{p}{T} (\underline{v} \cdot \nabla T)$$

The ^{last term of this} expression may be rearranged with the aid of the ideal-gas law to give:

$$\begin{aligned} (p/T)(\underline{v} \cdot \nabla T) &= p(\underline{v} \cdot \nabla(p/p)) \\ &= p \left(\frac{1}{p} (\underline{v} \cdot \nabla p) - \frac{p}{p^2} (\underline{v} \cdot \nabla p) \right) \\ &= (\underline{v} \cdot \nabla p) - \frac{p}{p} ((\nabla \cdot p \underline{v}) - p(\nabla \cdot \underline{v})) \end{aligned}$$

Solution Manual For Transport Phenomena Geankoplis

Arthur James Wells



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humidification filtration membrane separation gaseous membranes distillation liquid liquid extraction adsorption ion exchange crystallization and particle size reduction settling sedimentation centrifugation leaching evaporation and drying The authors conclude with convenient appendices on the properties of water compounds foods biological materials pipes tubes and screens The companion website trine.edu/transport5ed contains additional homework problems that incorporate today's leading software including Aspen CHEMCAD MATLAB COMSOL and Microsoft Excel **British Books in Print**, 1985

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