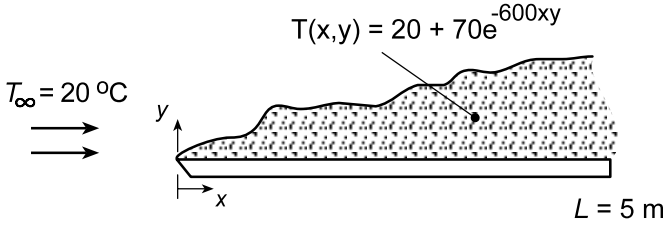
## PROBLEM 6.5

**KNOWN:** Temperature distribution in boundary layer for air flow over a flat plate.

**FIND:** Variation of local convection coefficient along the plate and value of average coefficient.

**SCHEMATIC:**



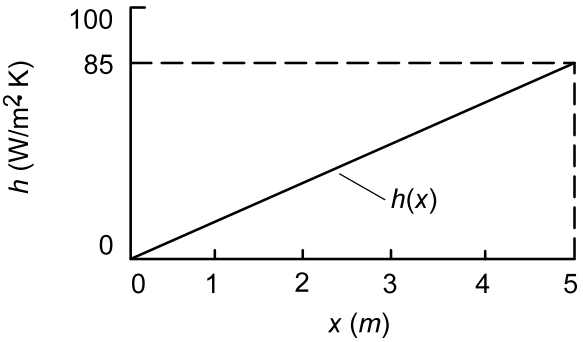

**ANALYSIS:** From Eq. 6.17,

$$h = -\frac{k\,\partial T/\partial y\big|_{y=0}}{(T_s - T_\infty)} = +\frac{k(70\times 600x)}{(T_s - T_\infty)}$$

where $T_s = T(x,0) = 90°C$. Evaluating k at the arithmetic mean of the freestream and surface temperatures, $\bar{T} = (20 + 90)°C/2 = 55°C = 328$ K, Table A.4 yields $k = 0.0284$ W/m·K. Hence, with $T_s - T_\infty = 70°C = 70$ K,

$$h = \frac{0.0284\,W/m\cdot K\,(42{,}000x)\,K/m}{70\,K} = 17x\left(W/m^2\cdot K\right) \qquad <$$

and the convection coefficient increases linearly with x.




The average coefficient over the range $0 \le x \le 5$ m is

$$\bar{h} = \frac{1}{L}\int_0^L h\,dx = \frac{17}{5}\int_0^5 x\,dx = \frac{17}{5}\frac{x^2}{2}\bigg|_0^5 = 42.5\,W/m^2\cdot K \qquad <$$