**PROBLEM 6.35**

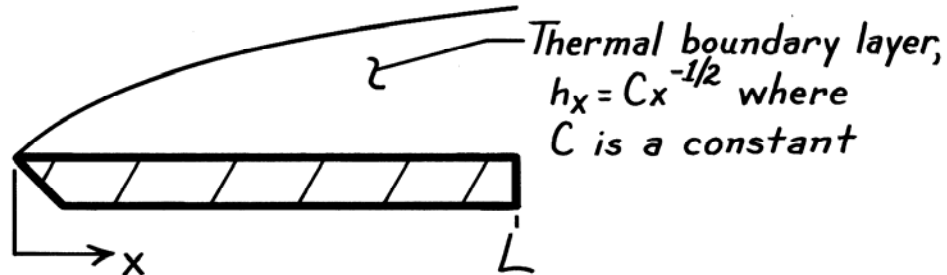**KNOWN:** Variation of $h_x$ with x for flow over a flat plate.

**FIND:** Ratio of average Nusselt number for the entire plate to the local Nusselt number at x = L.

**SCHEMATIC:**



Thermal boundary layer, $h_x = Cx^{-1/2}$ where C is a constant

**ANALYSIS:** The expressions for the local and average Nusselt numbers are

$$Nu_L = \frac{h_L L}{k} = \frac{\left(CL^{-1/2}\right)L}{k} = \frac{CL^{1/2}}{k}$$

$$\overline{Nu}_L = \frac{\overline{h_L} L}{k}$$

where

$$\overline{h_L} = \frac{1}{L}\int_0^L h_x \, dx = \frac{C}{L}\int_0^L x^{-1/2}dx = \frac{2C}{L}L^{1/2} = 2\,CL^{-1/2}.$$

Hence,

$$\overline{Nu}_L = \frac{2\,CL^{-1/2}(L)}{k} = \frac{2\,CL^{1/2}}{k}$$

and

$$\frac{\overline{Nu}_L}{Nu_L} = 2. \qquad\qquad <$$

**COMMENTS:** Note the manner in which $\overline{Nu}_L$ is defined in terms of $\overline{h}_L$. Also note that

$$\overline{Nu}_L \neq \frac{1}{L}\int_0^L Nu_x \, dx.$$