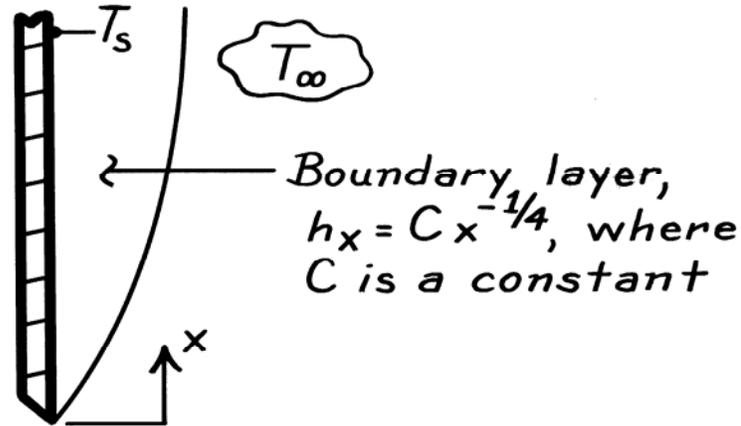


PROBLEM 6.8

KNOWN: Variation of local convection coefficient with x for free convection from a vertical heated plate.

FIND: Ratio of average to local convection coefficient.

SCHEMATIC:



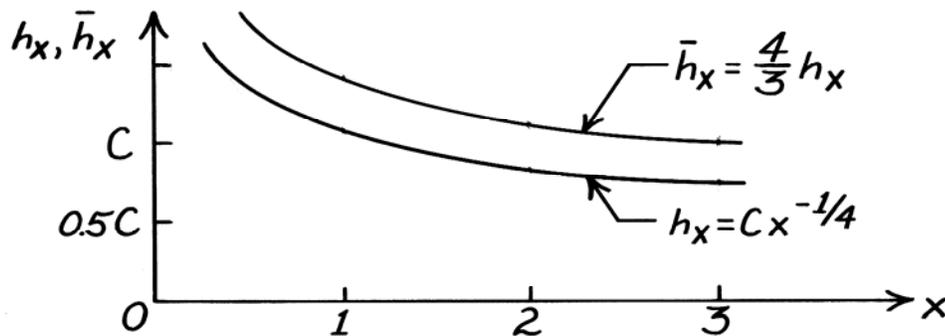
ANALYSIS: The average coefficient from 0 to x is

$$\bar{h}_x = \frac{1}{x} \int_0^x h_x dx = \frac{C}{x} \int_0^x x^{-1/4} dx$$

$$\bar{h}_x = \frac{4}{3} \frac{C}{x} x^{3/4} = \frac{4}{3} C x^{-1/4} = \frac{4}{3} h_x.$$

Hence,
$$\frac{\bar{h}_x}{h_x} = \frac{4}{3}.$$

The variations with distance of the local and average convection coefficients are shown in the sketch.



COMMENTS: Note that $\bar{h}_x / h_x = 4/3$ is independent of x . Hence the average coefficient for an entire plate of length L is $\bar{h}_L = \frac{4}{3} h_L$, where h_L is the local coefficient at $x = L$. Note also that the average *exceeds* the local. Why?