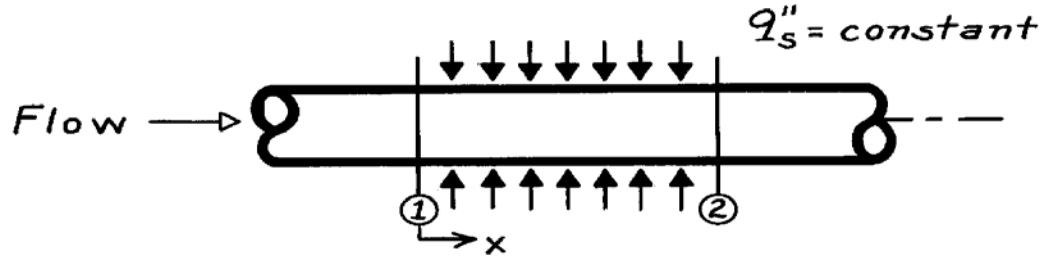


PROBLEM 8.13

KNOWN: Internal flow with constant surface heat flux, q_s'' .

FIND: (a) Qualitative temperature distributions, $T(x)$, under developing and fully-developed flow, (b) Exit mean temperature for both situations.

SCHEMATIC:



ASSUMPTIONS: (a) Steady-state conditions, (b) Constant properties, (c) Incompressible flow with negligible viscous dissipation.

ANALYSIS: Based upon the analysis leading to Eq. 8.39, note for the case of constant surface heat flux conditions,

$$\frac{dT_m}{dx} = \text{constant}.$$

Hence, regardless of whether the hydrodynamic or thermal boundary layer is fully developed, it follows that

$T_m(x)$ is linear and

$T_{m,2}$ will be the same for all flow conditions.

The surface heat flux can also be written, using Eq. 8.27, as

$$q_s'' = h[T_s(x) - T_m(x)].$$

Under fully-developed flow and thermal conditions, $h = h_{fd}$ is a constant. When flow is developing $h > h_{fd}$. Hence, the temperature distributions appear as below.

