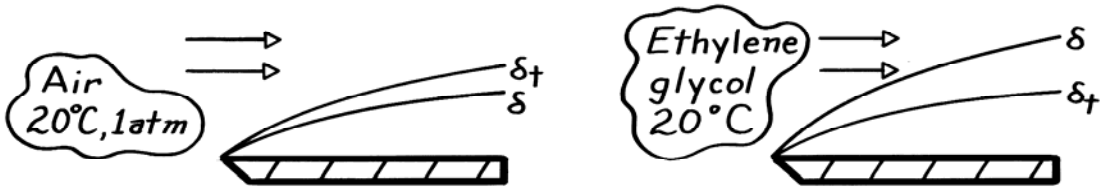
PROBLEM 6.36

KNOWN: Laminar boundary layer flow of air at 20°C and 1 atm having $\delta_t = 1.13\,\delta$.

FIND: Ratio δ/δ_t when fluid is ethylene glycol for same conditions.

SCHEMATIC:



ASSUMPTIONS: (1) Laminar flow.

PROPERTIES: *Table A-4,* Air (293K, 1 atm): Pr = 0.709; *Table A-5,* Ethylene glycol (293K): Pr = 211.

ANALYSIS: The Prandtl number strongly influences relative growth of the velocity, δ, and thermal, δ_t, boundary layers. For laminar flow, the approximate relationship is given by

$$\mathrm{Pr}^n \approx \frac{\delta}{\delta_t}$$

where n is a positive coefficient. Substituting the values for air

$$(0.709)^n = \frac{1}{1.13}$$

find that n = 0.355. Hence, for ethylene glycol it follows that

$$\frac{\delta}{\delta_t} = \mathrm{Pr}^{0.355} = 211^{0.355} = 6.69. \qquad <$$

COMMENTS: (1) For laminar flow, generally we find n = 0.33. In which case, $\delta/\delta_t = 5.85$.

(2) Recognize the physical importance of $\nu > \alpha$, which gives large values of the Prandtl number, and causes $\delta > \delta_t$.