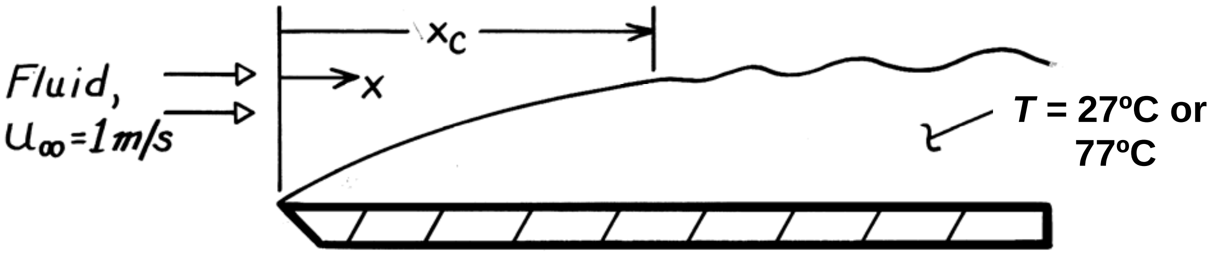
PROBLEM 6.21

KNOWN: Transition Reynolds number. Velocity and temperature of atmospheric air, engine oil, and mercury flow over a flat plate.

FIND: Distance from leading edge at which transition occurs for each fluid.

SCHEMATIC:



ASSUMPTIONS: Transition Reynolds number is $Re_{x,c} = 5 \times 10^5$.

PROPERTIES: For the fluids at T = 300 K and 350 K:

		$\nu(m^2/s)$	
Fluid	*Table*	T = 300 K	T = 350 K
Air (1 atm)	A-4	15.89×10^{-6}	20.92×10^{-6}
Engine Oil	A-5	550×10^{-6}	41.7×10^{-6}
Mercury	A-5	0.1125×10^{-6}	0.0976×10^{-6}

ANALYSIS: The point of transition is

$$x_c = Re_{x,c} \frac{\nu}{u_\infty} = \frac{5 \times 10^5}{1 \text{ m/s}} \nu.$$

Substituting appropriate viscosities, find

	$x_c(m)$	
Fluid	T = 300 K	T = 350 K
Air	7.95	10.5
Oil	275	20.9
Mercury	0.056	0.049

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COMMENTS: (1) Note the great disparity in transition length for the different fluids. Due to the effect which viscous forces have on attenuating the instabilities which bring about transition, the distance required to achieve transition increases with increasing ν. (2) Note the temperature-dependence of the transition length, in particular for engine oil. (3) As shown in Example 6.2, the variation of the transition location can have a significant effect on the average heat transfer coefficient associated with convection to or from the plate.