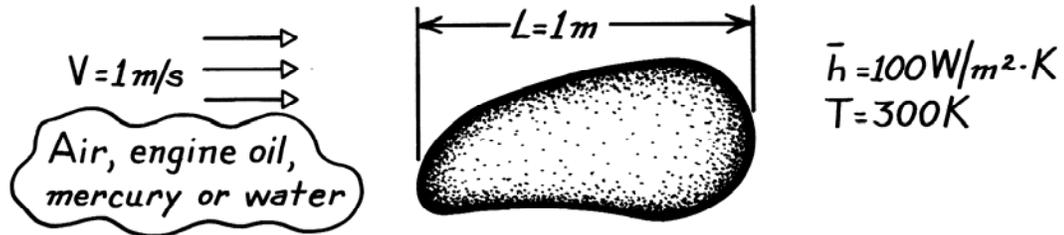


PROBLEM 6.33

KNOWN: Freestream velocity and average convection heat transfer associated with fluid flow over a surface of prescribed characteristic length.

FIND: Values of \overline{Nu}_L , Re_L , Pr , \overline{j}_H for (a) air, (b) engine oil, (c) mercury, (d) water.

SCHEMATIC:



PROPERTIES: For the fluids at 300K:

Fluid	Table	$\nu(m^2/s)$	$k(W/m \cdot K)$	$\alpha(m^2/s)$	Pr
Air	A.4	15.89×10^{-6}	0.0263	22.5×10^{-7}	0.71
Engine Oil	A.5	550×10^{-6}	0.145	0.859×10^{-7}	6400
Mercury	A.5	0.113×10^{-6}	8.54	45.30×10^{-7}	0.025
Water	A.6	0.858×10^{-6}	0.613	1.47×10^{-7}	5.83

ANALYSIS: The appropriate relations required are

$$\overline{Nu}_L = \frac{\overline{h}L}{k} \quad Re_L = \frac{VL}{\nu} \quad Pr = \frac{\nu}{\alpha} \quad \overline{j}_H = \overline{St}Pr^{2/3} \quad \overline{St} = \frac{\overline{Nu}_L}{Re_L Pr}$$

Fluid	\overline{Nu}_L	Re_L	Pr	\overline{j}_H	<
Air	3802	6.29×10^4	0.71	0.068	
Engine Oil	690	1.82×10^3	6403	0.0204	
Mercury	11.7	8.85×10^6	0.025	4.52×10^{-6}	
Water	163	1.17×10^6	5.84	7.74×10^{-5}	

COMMENTS: Note the wide range of Pr associated with the fluids.