PROBLEM 6.22

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	$v(m^2/s)$	k(W/m·K)	$\alpha(m^2/s)$	Pr
		6		7	
Air	A.4	15.89×10^{-0}	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

$\overline{\mathrm{Nu}}_{\mathrm{L}} = \frac{\overline{\mathrm{hL}}}{\mathrm{k}}$	$\operatorname{Re}_{\mathrm{L}} = \frac{\operatorname{VL}}{v}$	$\Pr = \frac{v}{\alpha}$ j _F	$_{\rm H} = \overline{\rm S} t {\rm Pr}^{2/3}$	$\overline{S}t = \frac{Nu_{L}}{Re_{L}Pr}$	
Fluid	$\overline{\mathrm{Nu}}_{\mathrm{L}}$	ReL	Pr	 ĴH	<
Air	3802	6.29×10^4	0.71	0.068	
Engine Oil Mercury	690 11.7	1.82×10 8.85×10^{6}	6403 0.025	0.0204 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.

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