CANKAYA UNIVERSITY
FACULTY OF ENGINEERING
MECHANICAL ENGINEERING DEPARTMENT

ME 313 HEAT TRANSFER

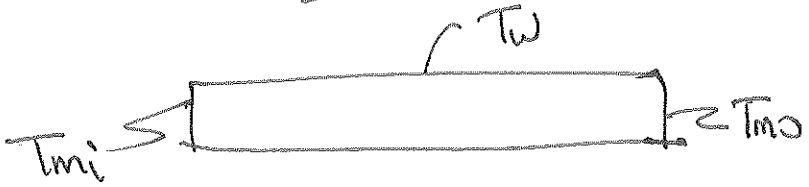
FALL 2016

QUIZ ON CHAPTER 8

KEY

A 2.0-cm-diameter smooth tube is maintained at a constant wall temperature of 90 ^{0}C. Water enters the tube at 40 ^{0}C and leaves at 60 ^{0}C. If the entering velocity is 3 m/s, calculate the length of tube necessary to accomplish the heating.

$$\bar{T}_m = \frac{T_{mi}+T_{mo}}{2} = \frac{40+60}{2} = 50^\circ C$$



$c_p = 4.174\ kJ/kg^\circ C$ $\quad k = 0.644\ \frac{W}{m^\circ C}$

$\rho = 988.8\ kg/m^3$ $\quad Pr = 3.64$

$\mu = 5.62 \times 10^{-4}\ \frac{kg}{m.s}$

$V = 3\ m/s$

$$Re_D = \frac{\rho V D}{\mu} = \frac{(988.8)(3)(2/100)}{5.62\times10^{-4}} = 1.055\times10^5$$

$$f = \frac{1}{[0.79\ln(1.055\times10^5) - 1.64]^2} = 0.0166$$

$$\bar{Nu}_D = \frac{(f/8)[Re_D - 1000]Pr}{1 + 12.7\sqrt{\frac{f}{8}}\left[Pr^{2/3} - 1\right]}$$

$$\simeq 441.4$$

$$\bar{h} = \frac{k}{D}\bar{Nu}_D = 14213\ W/m^2K$$

$$q = \dot{m} c_p (T_{mo} - T_{mi})$$

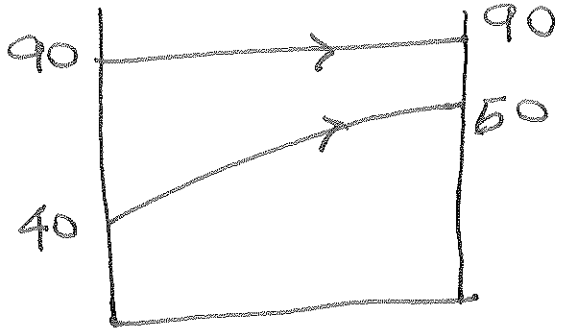
$$\dot{m} = \rho V A = \rho V \frac{\pi D^2}{4}$$

$$= (988.8)(3)\left(\frac{\pi}{4}\right)(0.02)^2$$

$$= 0.9319 \text{ kg/s}$$

$$q = (0.9319)(4174)(60-40) = 77796 \text{ J}$$

$$q = \bar{h} \pi D L \Delta T_{LMTD}$$



$$\Delta T_i = 90 - 40 = 50$$

$$\Delta T_o = 90 - 60 = 30$$

$$\Delta T_{LMTD} = \frac{\Delta T_o - \Delta T_i}{\ln(\Delta T_o / \Delta T_i)}$$

$$\Delta T_{LMTD} = \frac{30 - 50}{\ln(30/50)} = \frac{-20}{\ln(3/5)} = 39.15$$

$$(14213)(\pi)\left(\frac{2}{100}\right) L (39.15) = 77796$$

$$L = 2.22 \text{ m}$$