UTM
UNIVERSITI TEKNOLOGI MALAYSIA

No. Kad Pengenalan/No. Passpot
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Muka surat
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Jangan tulis apa-apa di ruangan ini
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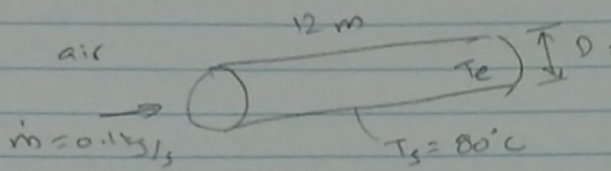
Example.

Air at atmospheric pressure and 27°C enters a 12 m long, 1.5 cm SD tube with a mass flow rate of 0.1 kg/s. The tube surface is maintained at a uniform temperature of 80°C.

Determine

(i) The average heat transfer coefficient

(ii) The rate of heat transfer to the air.



properties has to be evaluated at mean bulk temperature

$$T_b = \frac{T_i + T_e}{2}$$ but T_e is unknown, has to be assumed.

and $T_e < T_s$ (80°C)

→ Assume $T_b \approx 50°C$

From table for air at atmospheric pressure

$Pr = 0.7228$ $\quad \rho = 1.092\ kg/m^3$

$\nu = 1.798 \times 10^{-5}\ m^2/s$ $\quad C_p = 1007\ J/kg.K$

$k = 0.02735\ W/m.K$

$$Re = \frac{VD}{\nu}$$ from $\dot{m} = \rho A V$

$$\therefore V = \frac{\dot{m}}{\rho A}\ ; A = \frac{\pi D^2}{4} = 1.7671 \times 10^{-4}\ m^2$$

$$= 518.2\ m/s$$

$$Re = \frac{VD}{\nu} = 432321$$

∴ Can use Dittus-Boelter eqn.

$Nu = 0.023\ Re^{0.8}\ Pr^{0.4}$ (0.4 for heating)

$= 651.6$

$h = \frac{Nu\ k}{D} = 1188.05\ \frac{W}{m^2.K}$ #

(ii) $\dot{Q} = h A_s (LMTD)$

$A_s = \pi D L = 0.56549\ m^2$

$LMTD = \frac{\Delta T_e - \Delta T_i}{\ln\left(\frac{\Delta T_e}{\Delta T_i}\right)}$

$T_e = T_s - (T_s - T_i)\exp\left(\frac{-h A_s}{\dot{m} C_p}\right)$

$= 79.93\ ^\circ C$ (acceptable)

(50°C assumed mean bulk temp was ok)

$\rightarrow LMTD = 7.9339\ ^\circ C$

$\therefore \dot{Q} = h A_s (LMTD)$

$= 5330.3\ W$ #