Q.1 assuming that a man can be represent by a cylinder of 30 cm in diameter and 1.7 m high with a surface temperature of 30 °C, calculate the heat he would be loss while standing in a 36 km/h wind at 10 °C. Use $Nu_D = 0.027 (Re_D)^{0.805}(Pr)^{1/3}$

And physical properties of air at 20 °C are k=0.00259 W/mkPr=0.707, $\upsilon = 0.000015\ m^2/s$

Given Data

$D = 30cm = 0.3m$

$l = 1.7\ m$

$T_s = 30°C$

$T_\infty = 10°C$

$T_{mf} = \frac{T_\infty + T_s}{2} = \frac{30+10}{2} = 20°C$

$V = 36\ km/h = \frac{36\times1000}{3600} = 10 m/s$

$k = 0.00259\ W/mk$

$Pr = 0.707$

$\vartheta = 0.000015\ m^2/s$

$Re = \frac{\rho V D}{\mu} = \frac{VD}{\vartheta} = \frac{10\times0.3}{0.000015}$

$Re = 200000$

$Pr = 0.707$

$Nu = 0.027(Re)^{0.805}(Pr)^{1/3}$

$= 0.027(200000)^{0.805}(0.707)^{1/3}$

$Nu = 770.24$

$Nu = \frac{hD}{k} \Rightarrow 770.24 = \frac{h\times0.3}{0.00259}$

$h = 6.64$

$$\Phi = h A_s (T_s - T_\infty)$$

$$= 6.64 \times \pi \times D \times l \ (30 - 10)$$

$$= 6.64 \times \pi \times 0.3 \times 1.75 \ (30 - 10)$$

$$\boxed{\Phi = 213.08 \ W}$$

Q .2 A motor cycle cylinder consists of fins having outside diameter150 mm and total surface area of 0.27 m^2. Calculate the rate ofheat dissipation from cylinder fins when motorcycle is running at 20 m/s speed. The atmospheric air is at 25 °C and average fin surface temperature is 475 °C.the relevant thermo – physicalproperties at average temperature of 250 °C are:

K = 0.0427 w/m°C $\nu = 40.61 \times 10^{-6}$ m^2/s pr = 0.677

for turbulent flow use $Nu = 0.036\,(Re)^{0.8}\,(Pr)^{0.33}$

Given Data

$D = 150\,mm = 0.15\,m$

$A_s = 0.27\,m^2$

$V = 20\ m/s$

$T_\infty = 25\,°C$

$T_s = 475\,°C$

$T_{mf} = \frac{T_s + T_\infty}{2}$

$= \frac{475+25}{2}$

$= 250\,°C$

$Re = \frac{\rho V D}{\mu} = \frac{20 \times 0.15}{40.61 \times 10^{-6}} = 73873.43$

$Pr = 0.677$

$Nu = 0.036 \times (Re)^{0.8} \times (Pr)^{0.33}$

$= 0.036 \times (73873.43)^{0.8} \times (0.677)^{0.33}$

$= 248.42$

$Nu = \frac{hD}{K}$

$248.42 = \frac{h \times 0.15}{0.0427}$

$h = 70.71\ W/m^2K$

$\Phi = h A_s (T_s - T_\infty)$

$= 70.71 \times 0.27 \times (475 - 25)$

$= 8.591\ kW$

Q.3 750 kg/hour of cream at 10°C is pumped through 1.75 m length of 8 cm inner diameter tube which is maintained at 95 ℃. estimate the temperature of cream leaving the heated section and the rate of heat transfer from the tube to the cream. The relevant thermo physical properties of cream are:

$\rho = 1150\ kg/m^3$ $\quad$ $\mu = 22.5\ kg/ms$

$C_P = 2750\ J/kg\text{-}deg$ $\quad$ $k = 0.42\ W/m\text{-}deg$

Use the following correlation for flow of cream inside a tube:

$$Nu = 3.65 + \frac{0.067\left(\frac{D}{L} R_{e_D} Pr\right)}{1 + 0.04\left(\frac{D}{L} R_{e_D} Pr\right)^{1/3}}$$

T_i → heat → T_o

10°C $\quad$ Seen $\quad$?

$T_s = 95°C$ $\quad$ q

Given Data

$\dot{m} = 750\ kg/hr = \frac{7500}{3600} = 0.208\ kg/s$

$D = 8\ cm = 0.08\ m$

$L = 1.75\ m$

$\rho = 1150\ kg/m^3$

$C_p = 2750\ J/kg°C$

$k = 0.42\ W/m°C$

$T_i = 10°C$

$T_s = 95°C$

$\dot{m} = \rho A V$ $\quad$ $A_c = \pi/4\, d^2$

$= \pi/4 \times 0.08^2 = 5.026 \times 10^{-3}\ m^2$

$0.208 = 1150 \times 5.026 \times 10^{-3} \times V$

$V = 0.0359\ m/s$

$Re = \frac{\rho V D}{\mu} = \frac{1150 \times 0.0359 \times 0.08}{22.5}$

$Re = 0.147$

$Pr = \frac{\mu c_p}{k} = \frac{22.5 \times 2750}{0.42} = 147321.42$

Using given co-relation

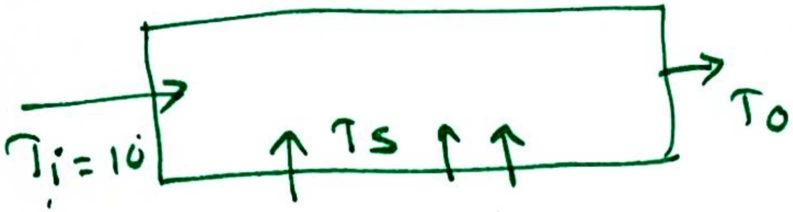
$$Nu = 3.65 + \frac{0.067\left[\frac{0.08}{1.75} \times 0.147 \times 147321.42\right]}{1 + 0.04\left[\frac{0.08}{1.75} \times 0.147 \times 147321.42\right]^{1/3}}$$

$$Nu = 51.45$$

$$Nu = \frac{hD}{K} \Rightarrow 51.45 = \frac{h \times 0.08}{0.42}$$

$$h = 270.11 \ \text{W/m}^2\text{K}$$

$$\left.\begin{aligned} \phi &= hA\,\Delta T \\ \phi &= mc_p\,\Delta T \end{aligned}\right]$$



$$hA\Delta T = mc_p\Delta T$$

$$270.11 \times \pi \times 0.08 \times 1.75 \times \left(95 - \left(\frac{T_o + 10}{2}\right)\right) = 0.208 \times 2750 \times (T_o - 10)$$

$$T_o = 25.99^\circ C$$

$$\phi = hA\Delta T$$

$$= 270.11 \times \pi \times 0.08 \times 1.75 \times (95 - 17.99)$$

$$\phi = 9147.73 \ W$$