ME 313 Heat Transfer
Quiz 7

FALL 2018

A fluid at 27°C flows with a velocity of 10 m/s across a 5-cm-OD tube whose surface is kept at a uniform temperature of 120°C. Determine the average heat transfer coefficients and the heat transfer rates per meter length of the tube for water.
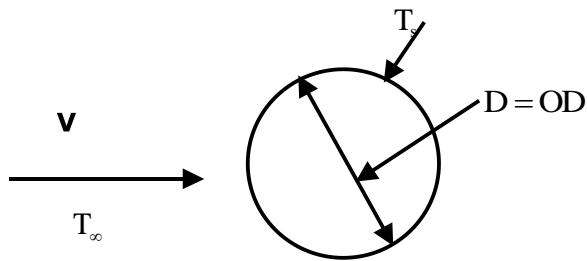
Solution

$$T_f = \frac{T_s + T_\infty}{2} = \left(\frac{27 + 120}{2}\right) = 73.5\,^0C$$

$$\nu = 0.402 \times 10^{-6}\,m^2/s$$

$$k = 0.662\,W/m\,^0C$$

$$Pr = 2.487$$

$$Re_D = \frac{DV}{\nu} = 1.24 \times 10^6$$

Let us use the following correlation

$$\overline{Nu}_D = 0.3 + \frac{0.62\,Re_D^{1/2}\,Pr^{1/3}}{[1 + (0.4/Pr)^{2/3}]^{1/4}}\left[1 + \left(\frac{Re_D}{282,000}\right)^{5/8}\right]^{4/5}$$

$$Nu_D = 2402$$

$$\overline{h} = \frac{k}{D}\overline{Nu}_D = 31800\,W/m^2\,^0C$$

$$q = \overline{h}(\pi D L)(T_s - T_\infty) = 464550\,W$$