Heat Transfer

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Practical Lecture 9

81. A volumetric flow rate of $0.025\,\mathrm{m^3\,s^{-1}}$ of air, at a temperature of 29°C, enters a duct with 0.15 m inner diameter and 0.17 m outer diameter. The thermal conductivity of the duct material is $0.15\,\mathrm{W\,m^{-1}\,K^{-1}}$. The duct is immersed in a water flow at a temperature of 17°C with a convection coefficient of $1500\,\mathrm{W\,m^{-2}\,K^{-1}}$.
    (a) Determine the length the duct should have in order to cool the air down to 21°C.
    (b) Determine the power of the fan required to promote the flow of air under the conditions of the previous question.

82. A water flow rate of $0.5\,\mathrm{kg\,s^{-1}}$ enters a circular pipe with 10 m length and 2 cm inner diameter. The pipe is subjected to a uniform heat flux at the rate of $5 \times 10^4\,\mathrm{W\,m^{-2}}$. Suppose that the velocity and temperature profiles are fully developed and consider the water properties at 20°C.
    (a) Calculate the pressure drop in the pipe.
    (b) Calculate the convection coefficient.
    (c) Calculate the difference between the wall temperature and the mean water temperature.
    (d) Calculate the variation of the mean water temperature between the inlet and outlet of the pipe.

84. (Homework) A flow rate of $0.05\,\mathrm{kg\,s^{-1}}$ of air at 245 K flows inside an annular tube with 9 m length, 3 cm inner diameter and 4 cm outer diameter. The air is heated by saturated steam at a pressure of 1×10^6 Pa which condenses inside the inner, co-axial tube. The outer surface of the annular tube is insulated. Calculate the average convection coefficient, the mean air temperature at the outlet of the annular tube and the rate of heat transfer.