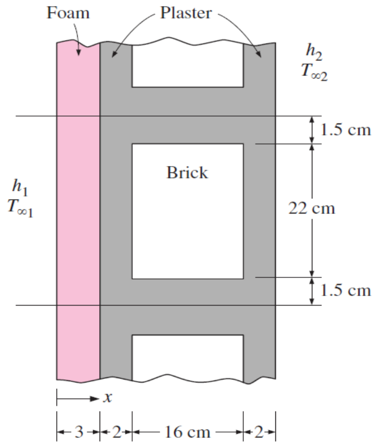
In-Class Exercises n°02 – Part B

Exercise 2.9

A **3-m-high** and **5-m-wide** wall consists of long **16-cm x 22-cm** cross section horizontal bricks (**k = 0.72 W/m·°C**) separated by **3-cm-thick** plaster layers (**k = 0.22 W/m·°C**). There are also **2-cm-thick** plaster layers on each side of the brick and a **3-cm-thick** rigid foam (**k = 0.026 W/m·°C**) on the inner side of the wall, as shown in **Fig. 3–6**. The indoor and the outdoor temperatures are **20°C** and **-10°C**, and the convection heat transfer coefficients on the inner and the outer sides are $\mathbf{h_1 = 10}$ $\mathbf{W/m^2 \cdot °C}$ and $\mathbf{h_2 = 25\ W/m^2 \cdot °C}$, respectively.

Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.

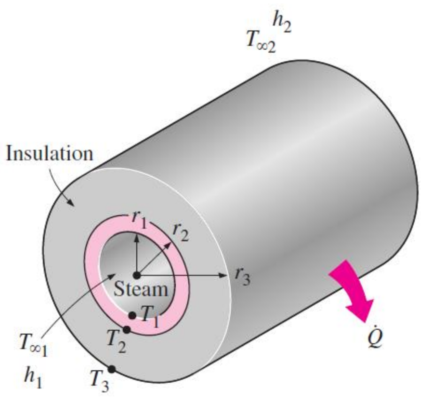


(**Figure 2.6**)

Exercise 2.10

Steam at $\mathbf{T_{\infty,1} = 320°C}$ flows in a cast iron pipe (**k = 80 W/m·°C**) whose inner and outer diameters are $\mathbf{D_1 = 5\ cm}$ and $\mathbf{D_2 = 5.5\ cm}$, respectively. The pipe is covered with **3-cm-thick** glass wool insulation with **k = 0.05 W/m·°C**. Heat is lost to the surroundings at $\mathbf{T_{\infty,2} = 5°C}$ by natural convection and radiation, with a combined heat transfer coefficient of $\mathbf{h_2 = 18\ W/m^2 \cdot °C}$.

Taking the heat transfer coefficient inside the pipe to be $\mathbf{h_1 = 60\ W/m^2 \cdot °C}$, determine the rate of heat loss from the steam per unit length of the pipe. Also determine the temperature drops across the pipe shell and the insulation.



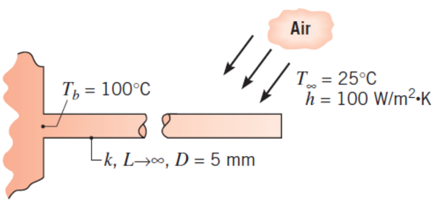
(**Figure 2.7**)

Exercise 2.11

A very long rod **5 mm** in diameter has one end maintained at **100°C**. The surface of the rod is exposed to ambient air at **25°C** with a convection heat transfer coefficient of $\mathbf{100\ W/m^2 \cdot K}$.

Determine the temperature distributions along rods constructed from pure copper, 2024 aluminium alloy, and type AISI 316 stainless steel. What are the corresponding rates of heat loss from the rods?

Estimate how long the rods must be for the assumption of infinite length to yield an accurate estimate of the rate of heat loss.

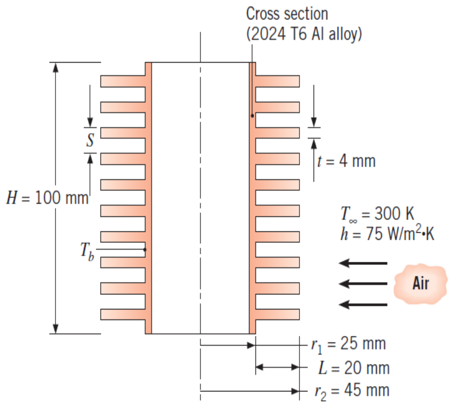


(**Figure 2.8**)

Exercise 2.12

The engine cylinder of a motorcycle is constructed of 2024-T6 aluminum alloy and is of height **H = 100 mm** and outer diameter **D = 2r$_1$ = 50 mm**. Under typical operating conditions, **q$_t$ = 2 kW** of heat is transferred from the cylinder to ambient air at **300 K**, with a convection coefficient of **75 W/m^2·K**. Annular fins are integrally cast with the cylinder to reduce the cylinder temperature. Consider ten equally-spaced fins, each of which are of thickness t **= 4 mm** and length **L = 20 mm**.

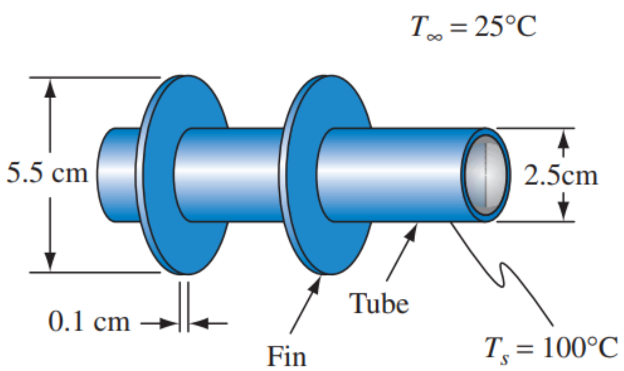
What reduction in the cylinder temperature can be achieved by use of the fins?



(**Figure 2.9**)

Exercise 2.13

To increase the heat dissipation from a **2.5-cm-OD** tube, circumferential fins made of aluminum (**k = 200 W/m.K**) are soldered to the outer surface. The fins are **0.1 cm thick** and have an outer diameter of **5.5 cm** as shown in **Fig. 2-10**. If the tube temperature is **100°C**, the environmental temperature is **25°C**, and the heat transfer coefficient between the fins and the environment is **65 W/m^2.K**, calculate the rate of heat loss from a fin.



(**Figure 2.10**)