42.14 An uninsulated hot water pipe runs horizontally through a room. The water entering the pipe is $130°F$. Where the pipe leaves the room, the water temperature is $110°F$. The room temperature is $70°F$. What is the film temperature?

A. $90°F$

B. $95°F$

C. $100°F$

D. $120°F$

The film temperature of a tube is the average of the bulk temperature of the ambient space, T_∞, and the average surface temperature, T_s. Note this represents the mean boundary layer condition i.e. film condition, for which the coefficient of heat transfer may be specified, if needed.

In this case only the film temperature needs to be calculated. Since the pipe is uninsulated, assume the surface temperature is the same as the hot water temperature, which is the average of the entering and leaving hot water temperature:

$$T_s = \frac{T_e + T_l}{2} = \frac{130°F + 110°F}{2} = 120°F$$

Calculate the film temperature:

$$T_f = \frac{T_s + T_\infty}{2} = \frac{120°F + 70°F}{2} = 95°F$$

Answer B

42.15 How much heat does a $3in$ horizontal hot water pipe lose to the ambient space per unit length by natural convection if the surrounding room has an average temperature of $70°F$, the surface temperature of the pipe is $100°F$, and the coefficient of thermal expansion for air is $1.79 \times 10^{-3} \, per \, °F$.

A. $19 \frac{Btu}{hr \cdot ft}$

B. $29 \frac{Btu}{hr \cdot ft}$

C. $45 \frac{Btu}{hr \cdot ft}$

D. $72 \frac{Btu}{hr \cdot ft}$

For convection problems in general, a reasonable starting point is always Newton's Law of Cooling:

$$\dot{Q} = hA\Delta T$$

where h is the convection heat transfer coefficient.