32.24 **The average temperature of a fluid flowing in a $8in$ nominal schedule 80 steel pipe is $40°F$. The surface temperature on the outside of the pipe is $43°F$. The thermal conductivity of steel is $30\frac{Btu}{hr \cdot ft \cdot °F}$. What is the rate of heat transfer per linear foot into the water by conduction?**

A. $4500\frac{Btu}{hr \cdot ft}$

B. $5900\frac{Btu}{hr \cdot ft}$

C. $7100\frac{Btu}{hr \cdot ft}$

D. $8700\frac{Btu}{hr \cdot ft}$

Draw the pipe cross section and add dimensions from the Schedule 80 Steel Pipe table. For an $8in$ nominal schedule 80 pipe, $D_i = 7.625in$. Add two times the thickness to obtain the outside diameter. For use in the next step, find the inside and outside radii.

$$D_o = D_i + 2t = 7.625in + 2\left(0.5in\right) = 8.625in$$

$$r_i = \frac{D_i}{2} = \frac{7.625in}{2} = 3.8125in$$

$$r_o = \frac{D_o}{2} = \frac{8.625in}{2} = 4.3125in$$

Modify the formula for Conduction Through a Cylindrical Wall (Heat Loss Through a Pipe) by dividing both sides by the length, L, to specify the conduction *per unit length*. Note r_2 corresponds to the outside diameter, r_o, and r_1 corresponds to the inside diameter, r_i. This is imperative as interchanging the two would lead to a negative value in the denominator. Substitute and solve for $\dot{q}$,the heat transfer per linear foot.

$$\dot{Q} = \frac{2\pi kL\left(T_1 - T_2\right)}{ln\left(\frac{r_2}{r_1}\right)}$$

$$\dot{q} = \frac{\dot{Q}}{L} = \frac{2\pi k\left(T_1 - T_2\right)}{ln\left(\frac{r_2}{r_1}\right)}$$

$$\dot{q} = \frac{2\pi\left(30\frac{Btu}{hr \cdot ft \cdot °F}\right)\left(43°F - 40°F\right)}{ln\left(\frac{4.3125in}{3.8125in}\right)} = 4489\frac{Btu}{hr \cdot ft}$$

Answer A