## Chapter 16 Problem 65 [†]

**Given**

$D = 15\ cm = 0.15\ m$
$r = 0.075\ m$
$l = 65\ cm = 0.65\ m$
$P = 34\ kW = 34000\ W$

**Solution**

What is the temperature of the log?

First find the surface area of the log. Each end of the log will have the area of a circle.

$$A_{end} = \pi r^2 = \pi(0.075\ m)^2 = 0.0177\ m^2$$

The side of the cylinder has an area of

$$A_{side} = 2\pi r l = 2\pi(0.075\ m)(0.65\ m) = 0.306\ m^2$$

The total surface area of the log is then

$$A = A_{side} + 2A_{end} = (0.306\ m^2) + 2(0.0177\ m^2) = 0.341\ m^2$$

From the Stefan-Boltzmann equation we have

$$P = \epsilon\sigma A T^4$$

Assuming emissivity is 1, then the temperature is

$$T = \left(\frac{P}{\sigma A}\right)^{1/4} = \left(\frac{34000\ W}{(5.67 \times 10^{-8}\ W/m^2 \cdot K^4)(0.341\ m^2)}\right)^{1/4} = 1150\ K$$

[†]Problem from Essential University Physics, Wolfson