

**Problem 1.6-4: Wire with Ohmic Heating**

A wire is subjected to ohmic heating (i.e., a current runs through it) while it is convectively cooled. The ends of the wire have fixed temperatures. Describe how you would determine whether the extended surface approximation (i.e., the approximation in which you treat the temperature of the wire as being one-dimensional along its length and uniform radially) is appropriate when solving this problem.

The justification of the extended surface approximation is related to computing the Biot number, the ratio of the resistance that is being neglected (conduction radially within the wire) to the resistance(s) being considered (convection from the wire surface). For this problem, the Biot number would be:

$$\frac{r h}{k} \quad (1)$$

where  $r$  is the radius of the wire,  $h$  is the heat transfer coefficient, and  $k$  is the wire conductivity. Note that the rate of ohmic heating is not important for this calculation because the ohmic heating must be both conducted radially and convected from the surface.