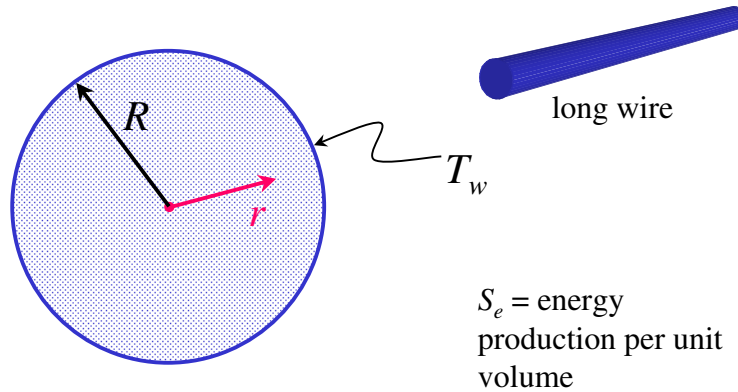


**Example 5: Heat Conduction with Generation**

What is the steady state temperature profile in a wire if heat is generated uniformly throughout the wire at a rate of  $S_e \text{ W/m}^3$  and the outer radius is held at  $T_w$ ?



**Energy Balance**

$$\left( \begin{array}{c} \text{rate of} \\ \text{energy} \\ \text{accumulation} \end{array} \right) = \underbrace{\left( \begin{array}{c} \text{rate of} \\ \text{energy} \\ \text{in} \end{array} \right) - \left( \begin{array}{c} \text{rate of} \\ \text{energy} \\ \text{out} \end{array} \right)}_{\text{Convective and conduction terms - energy that passes through boundaries}} + \underbrace{\left( \begin{array}{c} \text{rate of} \\ \text{energy} \\ \text{production} \end{array} \right)}_{\text{e.g. chemical reaction, electrical current}}$$

Convective and conduction terms - energy that passes through boundaries

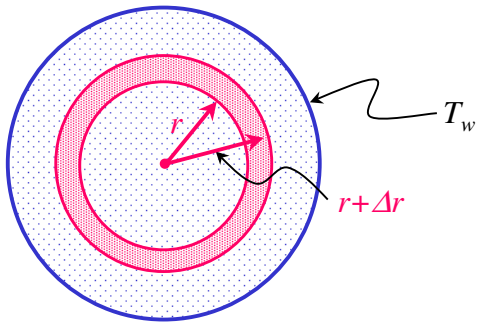
e.g. chemical reaction, electrical current

**conduction** - Fourier's law

**convection** - due to flow

Example 5: Heat Conduction with **Generation**

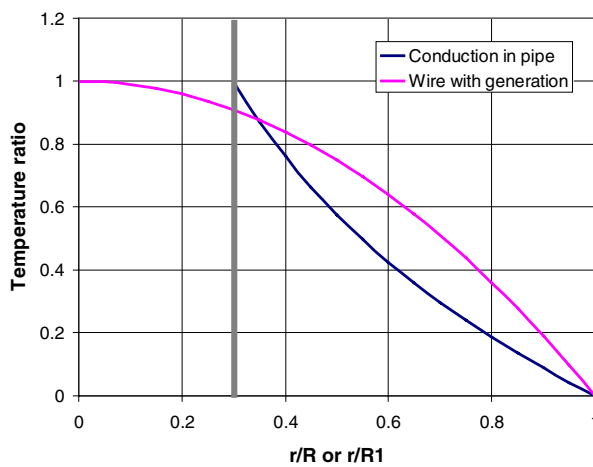
**Shell Balance:** choose control volume



contributions to energy transport:

- generation
- radial conduction

Compare solutions



$$\frac{T - T_1}{T_1 - T_2} \frac{1}{\ln \frac{R_1}{R_2}} = \ln \frac{r}{R_1}$$

$$\frac{T - T_w}{S_e R^2 / 4k} = 1 - \left(\frac{r}{R}\right)^2$$