PROBLEM 4.8

KNOWN: Heat generation in a buried spherical container.

FIND: (a) Outer surface temperature of the container, (b) Representative isotherms and heat flow lines.

SCHEMATIC:

ASSUMPTIONS: (1) Steady-state conditions, (2) Soil is a homogeneous medium with constant properties.

PROPERTIES: *Table A-3*, Soil (300K): k = 0.52 W/m·K.

ANALYSIS: (a) From an energy balance on the container, $q = \dot{E}_g$ and from the first entry in Table 4.1,

$$q = \frac{2\pi D}{1 - D/4z} k (T_1 - T_2).$$

Hence,

$$T_1 = T_2 + \frac{q}{k} \frac{1 - D/4z}{2\pi D} = 20°C + \frac{500W}{0.52 \frac{W}{m \cdot K}} \frac{1 - 2m/40m}{2\pi(2m)} = 92.7°C \qquad <$$

(b) The isotherms may be viewed as spherical surfaces whose center moves downward with increasing radius. The surface of the soil is an isotherm for which the center is at z = ∞.