7.7

A flame radiates 40% of its energy. The fuel supply is 100 g/s and its heat of combustion is 30 kJ/g. A thin drapery is 3 m from the flame. Assume piloted ignition. When will the drapery ignite? The ambient temperature is 20 C and the heat transfer coefficient of the drapery is 10 W/(m^2K). The drapery properties are:

$rho := 40 \quad cp := 1400 \quad Tig := 350 + 273 \quad dd := 0.002 \quad he := 10 \quad Te := 20 + 273$

invert eqn 7.27 in terms of tig

If we use spherical approximation of heat flux

$Xr := 0.4 \quad HRR := 30 \cdot 100 \cdot 1000 \quad Rad := 3$

$$qrad := \frac{Xr \cdot HRR}{4 \cdot \pi \cdot Rad^2}$$

$$qrad = 1.061 \times 10^4 \quad \frac{W}{m^2}$$

$$tig := \frac{(-rho \cdot cp \cdot dd) \cdot \ln\left[1 - \frac{he \cdot (Tig - Te)}{qrad}\right]}{he} \qquad tig = 4.172 \quad \text{seconds}$$

if we use cylindrical approximation $H := Rad$

$$qrad\_cyl := \frac{Xr \cdot HRR}{2 \cdot \pi \cdot Rad \cdot H} \qquad qrad\_cyl = 2.122 \times 10^4 \quad \frac{W}{m^2}$$

$$tig\_cyl := \frac{(-rho \cdot cp \cdot dd) \cdot \ln\left[1 - \frac{he \cdot (Tig - Te)}{qrad\_cyl}\right]}{he} \qquad tig\_cyl = 1.893 \quad \text{seconds}$$