10.4.4
Fuel Surface Temperature

So far we have assumed we know T_s, but T_s is a function of axial position (z)

From heat transfer considerations;

changes with z

$$T_s = T_{coolant} + \frac{P}{2\pi R_c U}$$

$$T_{inlet} + \frac{\#\,rods}{QC_{pc}} \int_0^z P(z')dz' \qquad \frac{1}{U} = \frac{1}{h_{gap}} + \frac{t_c}{k_c} + \frac{1}{h_{coolant}}$$

==========

Table 10.5 - Note Importance of Gap

10.4.5
Conductance of Fuel Cladding -Gap

Initial Conditions	End of life
gap thickness ≈ 100 μm	*0 to few μm*
gap gas.....He	*He + Kr+ Xe*
gas pressure ≈1bar	*50-100 bar*

Conductance of open gap

$$h_{gap} = \frac{k_g}{t_{gap}} + \frac{4\sigma T^3}{\left(\frac{1}{\varepsilon_c}\right) + \left(\frac{1}{\varepsilon_f}\right) - 1}$$

Thermal Conductivity of Gases

$$k_g \text{ (pure gas)} = A \times 10^{-6} \; T^{0.79} \qquad \text{W/cm}^\circ\text{C}$$

15.8 He
1.15 Kr
0.72 Xe

Thermal Conductivity of Gas Mixture

$$k_g = (k_{He})^{x_{He}} (k_{Xe})^{1-x_{He}}$$

At normally small gaps during operation, the gas conduction term dominates

---

Closed Gap

When fuel expands to contact the cladding, the heat transfer is across the various contact points and the gas in between

$$h_{gap} = \left[\frac{k_g}{(\delta + g_c + g_f)}\right] + C\left\{\frac{2k_f k_c}{k_f + k_c}\right\}\left\{\frac{P_i}{\delta^{\frac{1}{2}} H}\right\}$$

$$h_{gap} = \frac{1 Watt}{cm^2\,^{\circ}C}$$