(21.1) In a BWR the minimum and maximum heat fluxes at the fuel rod surface are 0.46 and 1.08 MW m^{-2} at a coolant temperature of 283°C. The rods have an outer diameter of 12.7 mm with a cladding of 0.8 mm thick Zircaloy-4; assume a negligible fuel cladding gap and neglect the temperature drop between coolant and cladding and across the fuel-cladding gap. Assume that data in Table 21.1 are valid at all temperatures and k_{UO2} = 4 W/m°C. What are the highest and lowest fuel-center temperatures?

$k_{UO2} := 4 \cdot watt \cdot m^{-1} \cdot K^{-1}$ $T_{coolant} := (273 + 283) \cdot K$ $\Delta T_0 := 0 \cdot K$ $l_1 := 1 \cdot m$

$k_c := 16 \cdot watt \cdot m^{-1} \cdot K^{-1}$ $d_{outer} := 12.7 \cdot mm$ $r_c := \frac{d_{outer}}{2}$ $t_{can} := 0.8 \cdot mm$

$r_i := r_c - t_{can}$ $r_f := r_i$ $Area := \pi \cdot d_{outer} \cdot l_1$ $p_{surf} := 0.46 \cdot 10^6 \cdot watt \cdot m^{-2}$

$V_{fuel} := \pi \cdot r_f^2 \cdot l_1$ $p_f := p_{surf} \frac{Area}{V_{fuel}}$ $p_f = 1.897 \cdot 10^8 \cdot watt \cdot m^{-3}$

$\Delta T_{can} := p_f r_f^2 \cdot \frac{r_c - r_i}{2 \cdot r_i \cdot k_c}$ $\Delta T_{can} = 26.315 \cdot K$

$\Delta T_{gap} := 0 \cdot K$

$T_{rf} := T_{coolant} + \Delta T_0 + \Delta T_{can} + \Delta T_{gap}$

$T_{center} := T_{rf} + \frac{p_f r_f^2}{4 \cdot k_{UO2}}$ $T_{center} = 947.44 \cdot K$

$T_{cC} := \frac{T_{center}}{1 \cdot K} - 273$ Lowest: $T_{cC} = 674.44$ °C

$p_{surf} := 1.08 \cdot 10^6 \cdot watt \cdot m^{-2}$

$V_{fuel} := \pi \cdot r_f^2 \cdot l_1$ $p_f := p_{surf} \frac{Area}{V_{fuel}}$ $p_f = 4.453 \cdot 10^8 \cdot watt \cdot m^{-3}$

$\Delta T_{can} := p_f r_f^2 \cdot \frac{r_c - r_i}{2 \cdot r_i \cdot k_c}$ $\Delta T_{can} = 61.784 \cdot K$

$\Delta T_{gap} := 0 \cdot K$

$T_{rf} := T_{coolant} + \Delta T_0 + \Delta T_{can} + \Delta T_{gap}$

$T_{center} := T_{rf} + \frac{p_f r_f^2}{4 \cdot k_{UO2}}$ $T_{center} = 1.475 \cdot 10^3 \cdot K$

$T_{centerC} := \frac{T_{center}}{1 \cdot K} - 273$ convert to °C Highest: $T_{centerC} = 1202.034$ °C