Property values and parameters used:

$Fuel\ radius, R_f = 0.5\ cm$

$Fuel\ rod\ height, h = 100\ cm$

$Gap\ thickness, t_g = 0.005\ cm$

$Cladding\ thickness, t_c = 0.1\ cm$

$Linear\ heat\ rate, LHR = 350 \frac{watt}{cm}$

Here, the temperature (T) dependent thermal conductivity for fuel can be expressed as

$k(T) = \frac{1}{3.8+0.0217\times T}$, where T is temperature

$\text{Thermal conductivity of gap}, \mathrm{k_g} = 0.001514 \frac{\mathrm{watt}}{\mathrm{cm.K}}$

$\text{Thermal conductivity of cladding}, \mathrm{k_c} = 0.17 \frac{\mathrm{watt}}{\mathrm{cm.K}}$

Equations and other parameters:

If the length of the fuel rod is $2Z_0$, with midpoint Z_0, then the equation for axial LHR can be written as:

$LHR\ \left(\frac{z}{Z_0}\right) = LHR^{\circ} \cos\ [\frac{\pi}{2\gamma}(\frac{z}{Z_0} - 1)]$; where LHR°= midpoint Linear heat rate

$As\ we\ are\ using\ volumetric\ heat\ rate,$

$LHR\ \left(\frac{z}{Z_0}\right) = LHR^{\circ} \cos\ [\frac{\pi}{2\gamma}(\frac{z}{Z_0} - 1)]/\pi r^2$; where r = 0.5 cm

The variation in coolant temperature can be expressed as:

$$T_{cool} - T_{cool}^{in} = \frac{1}{1.2}\frac{Z^{\circ}LHR^{\circ}}{\dot{m}C_{pw}}\ \{\sin(1.2) + \sin\left[1.2\left(\frac{Z}{Z^{\circ}} - 1\right)\right]\}$$

$$T_{cool} = 500 + 13.89 \times \ \{\sin(1.2) + \sin\left[1.2\left(\frac{z}{Z^{\circ}} - 1\right)\right]\}$$

Here,

T_{cool} = coolant temperature

T_{cool}^{in}= coolant inlet temperature = 500 K

$\dot{m}$ = mass flow rate of coolant = 0.24 Kg/sec

C_{pw}= specific heat capacity of coolant (water) = 4200 J/Kg.K

Result and Discussion:

The results are plotted and added below. As the maximum fission rate occurs at the center of the fuel and mid length of the fuel approximately, the nature of the curve obtained from the plot can be verified as well.

Fig. 1-3 represents linear vector line temperature profile at the fuel height of 25 cm, 50 cm and 100 cm. It can be seen that as coolant is moving upward through the rod the fuel temperature profile through the road is maximum toward the center and minimum toward the upper and lower part of the fuel rod. In order to have a clear idea, a temperature profile for fuel centerline is plotted axially taking points at 0, 25, 50, 75 and 100 cm respectively which clearly shows the cosine nature of the axial fuel rod temperature.

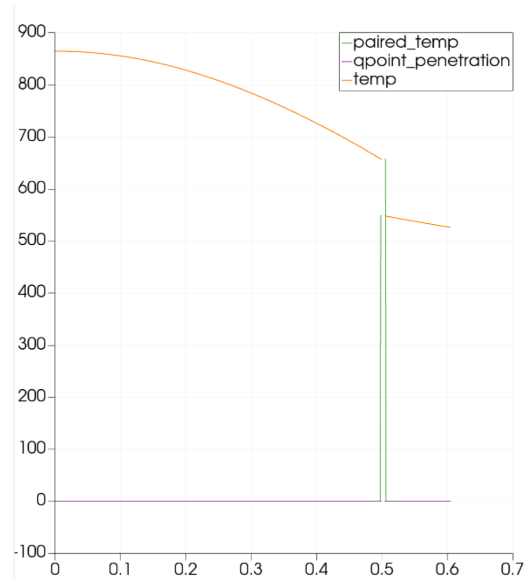

Fig. 1: Fuel radial temperature profile at 25 cm height

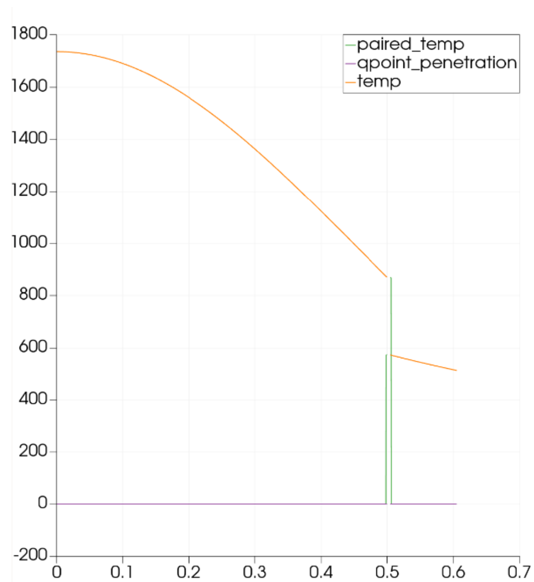

Fig. 2: Fuel radial temperature profile at 50 cm height

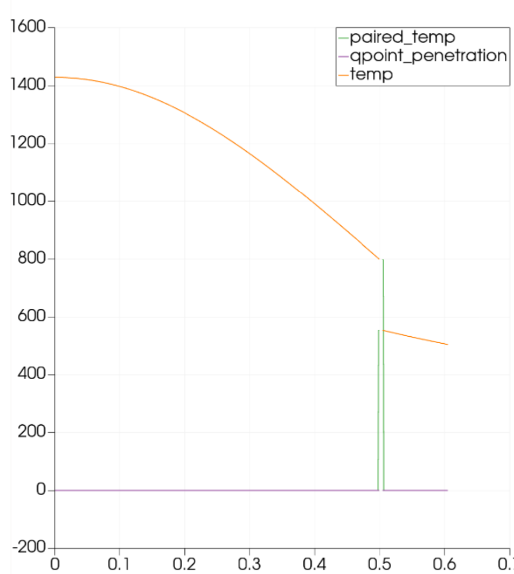

Fig. 3: Fuel radial temperature profile at 100 cm height

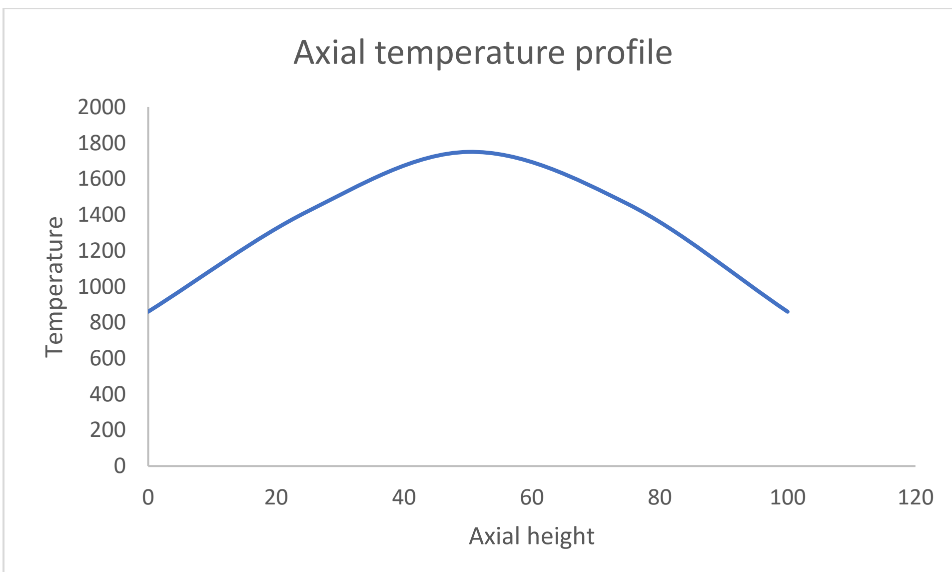

Fig. 4: Axial cosine nature of the fuel centerline temperature profile

Conclusion: The final peak centerline temperature was found at 51 cm height of the fuel rod which is close to the ideal case. Also, the cosine nature of the fuel centerline temperature is not uniform at the both sides as there may be some problem with the convergence of the meshing of the rod. The geometry is meshed as 300 X 300 in both direction but fuel height and width are not the same. It would be very practical to compare many more meshing size combinations to find the optimum result which will give a smother cosine curve. Some considerable points that can be considered are stated below:

1. Changing the meshing size can be done.
2. Increasing or decreasing the coolant flow is also observable.
3. Built in empirical co-relation was used for the gap region which had no mesh. This empirical relation may also had some adverse effect on the analysis.