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UPGRADING THE HFIR THERMAL-HYDRAULIC LEGACY CODE USING COMSOL

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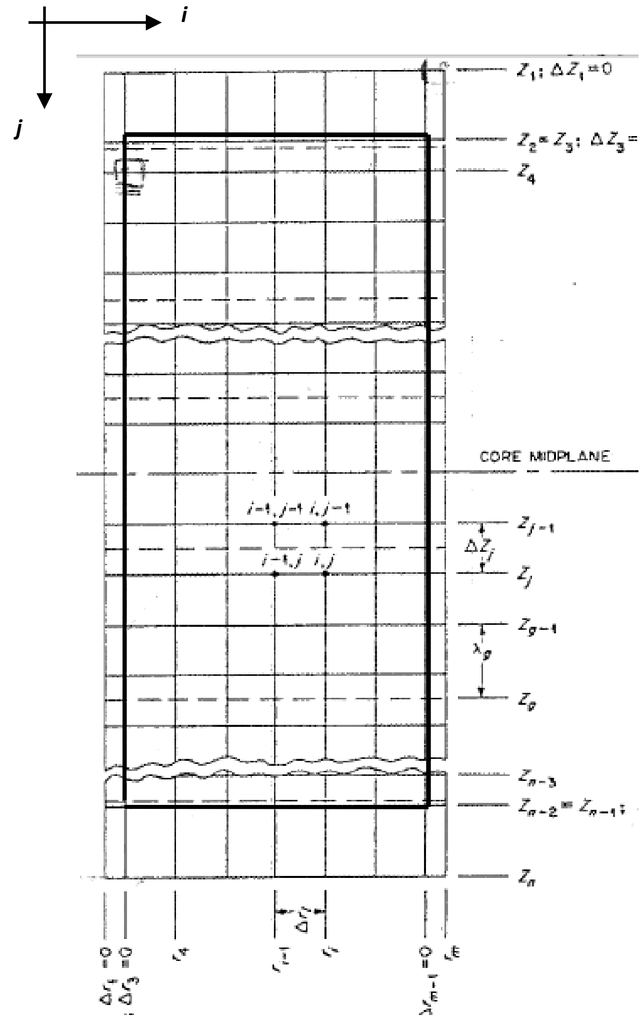
Conservatisms Inherent in the Steady State Heat Transfer Code (SSHTC)

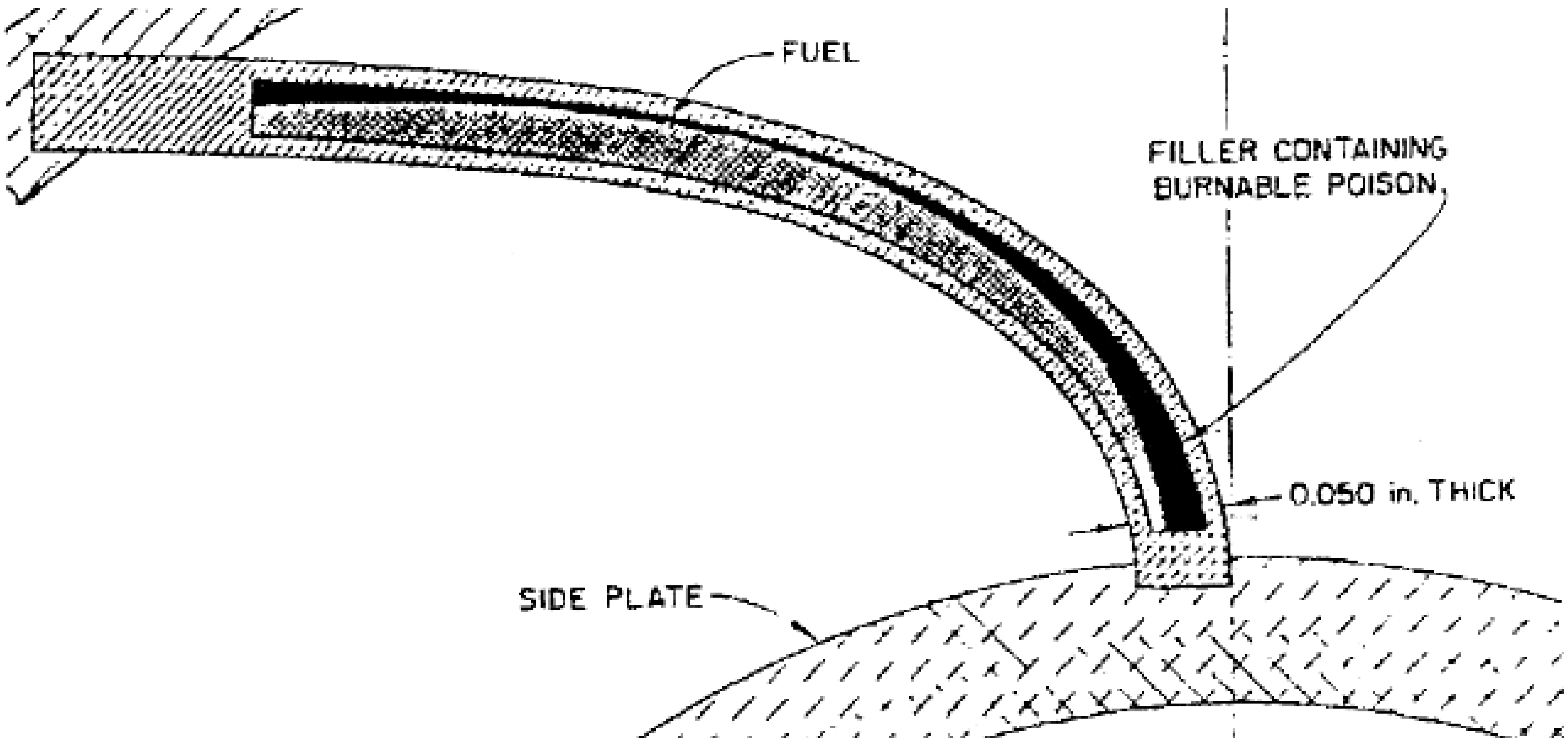
- One dimensional thermal energy transport in the solid domain.
- Convection coefficient specification through Nusselt number correlation
- Bulk water temperature specification
- Planar fuel plate geometry

Fuel Plate Discretization Used in the SSHTC

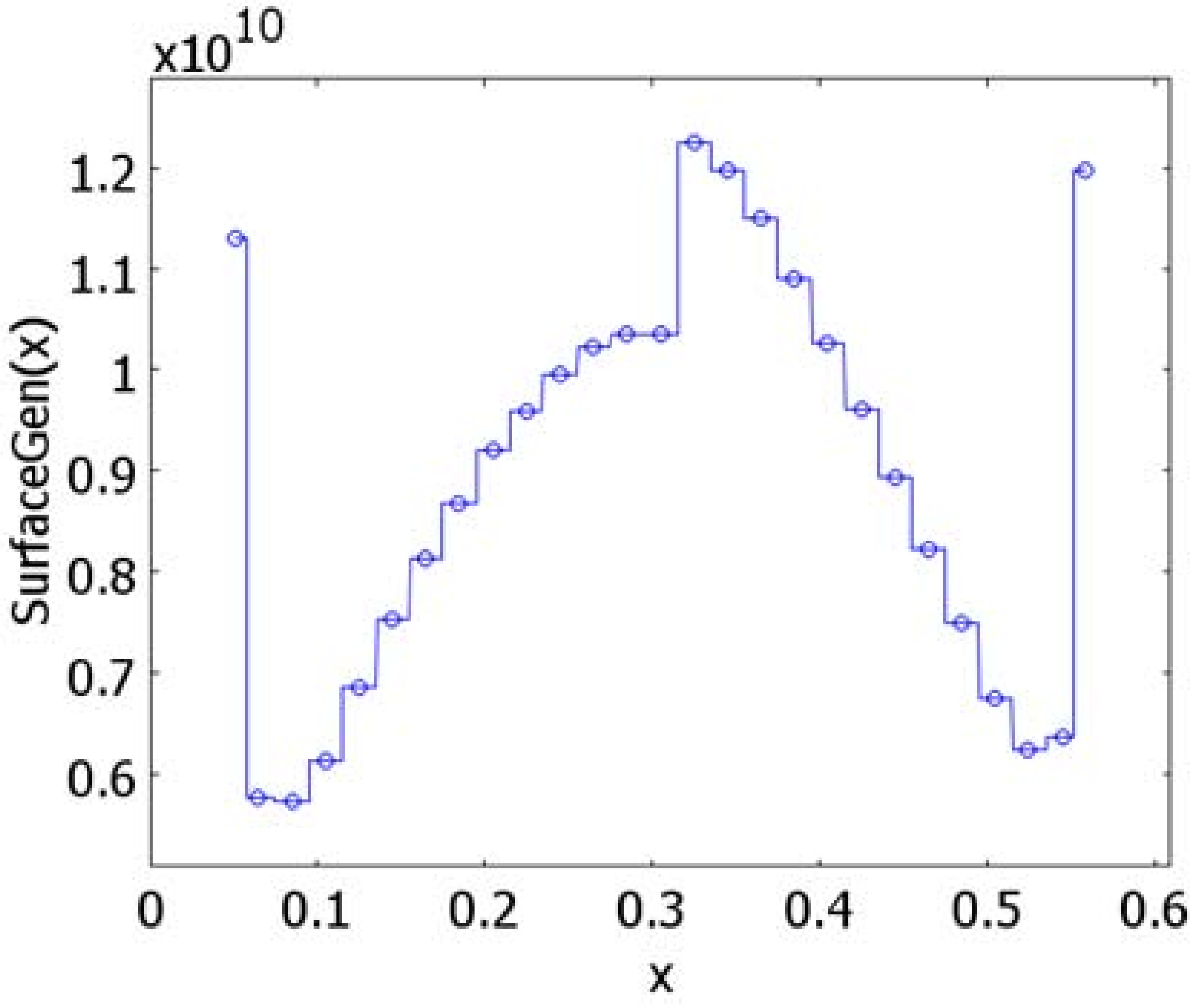
- *i*, *j* indices represent the arclength and axial coordinates of the fuel plate discretization lattice respectively
- Outlined domain represents active fuel region
- Fluid flow is from the top down



HFIR Fuel Plate Geometry

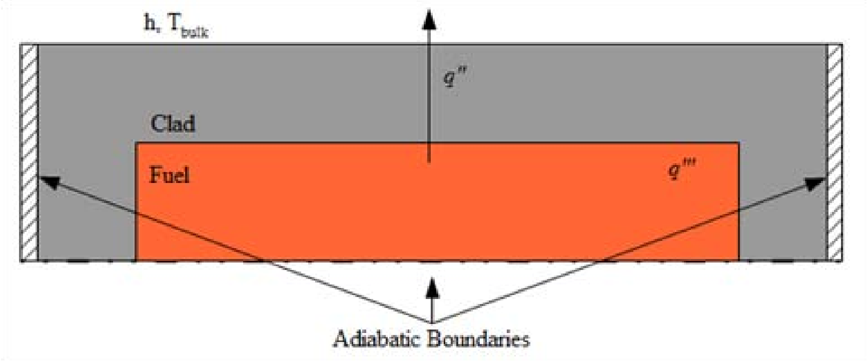


Power Density Profile Used in HFIR Fuel Plate

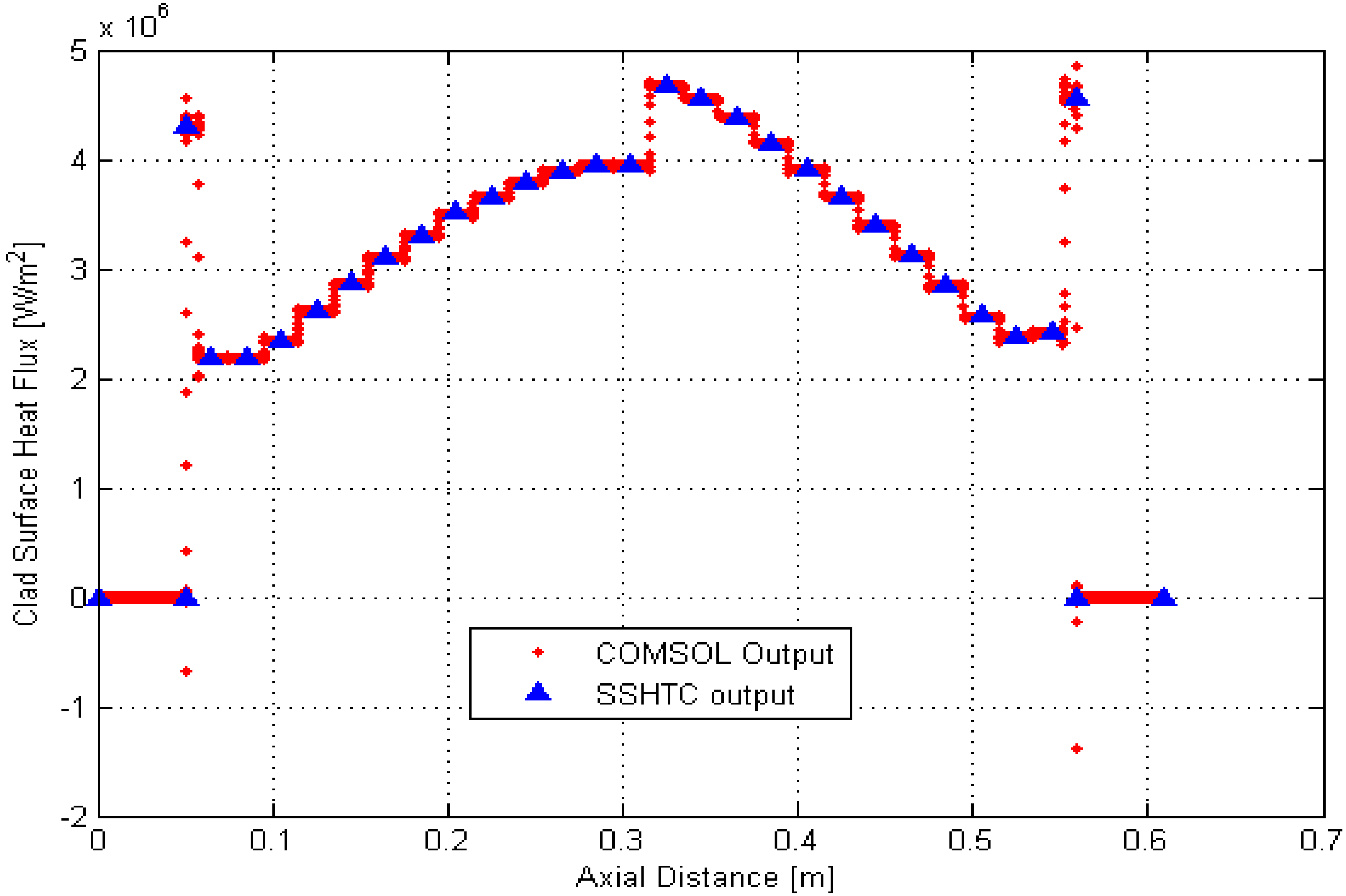


Two Dimensional Geometry of HFIR Fuel Plate Used in COMSOL

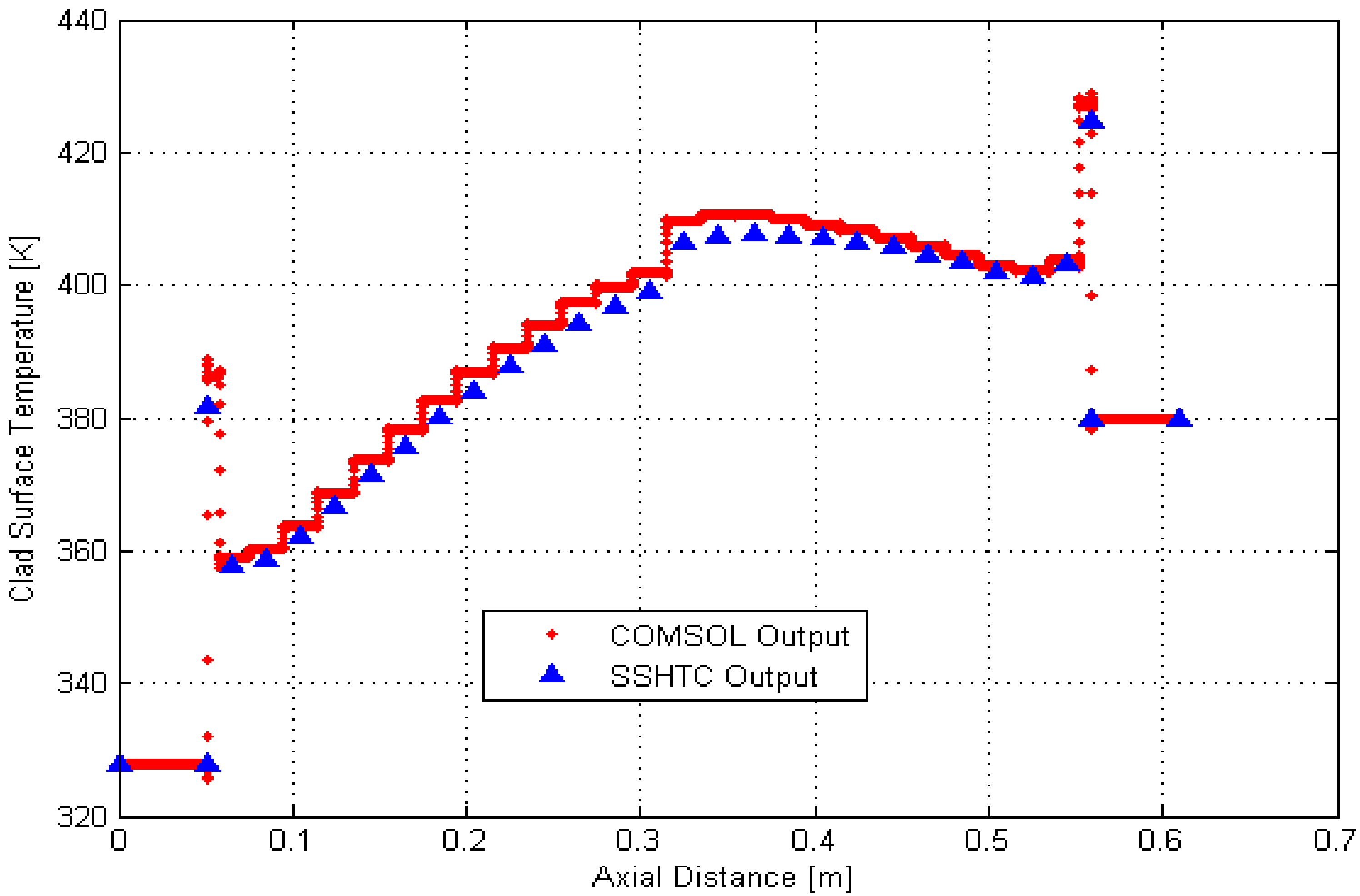
- Thermal energy diffuses normal to the clad surface only
- SSHTC output provides the thermal quantities for the convection boundary condition
- Hatched walls are adiabatic constraints imposed in the SSHTC.
- Distributed power density profile used in the fuel



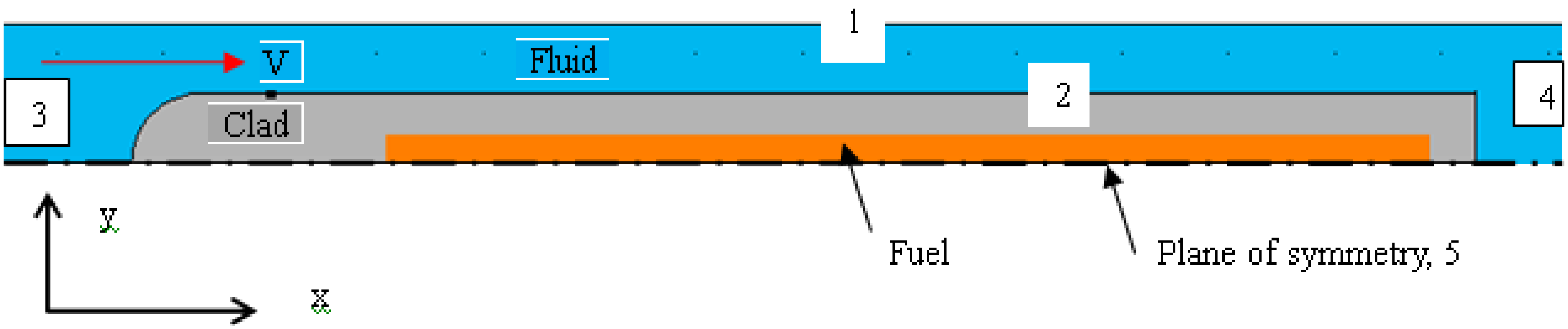
Clad Surface Heat Flux Comparison Between the SSHTC Results and the COMSOL Simulation



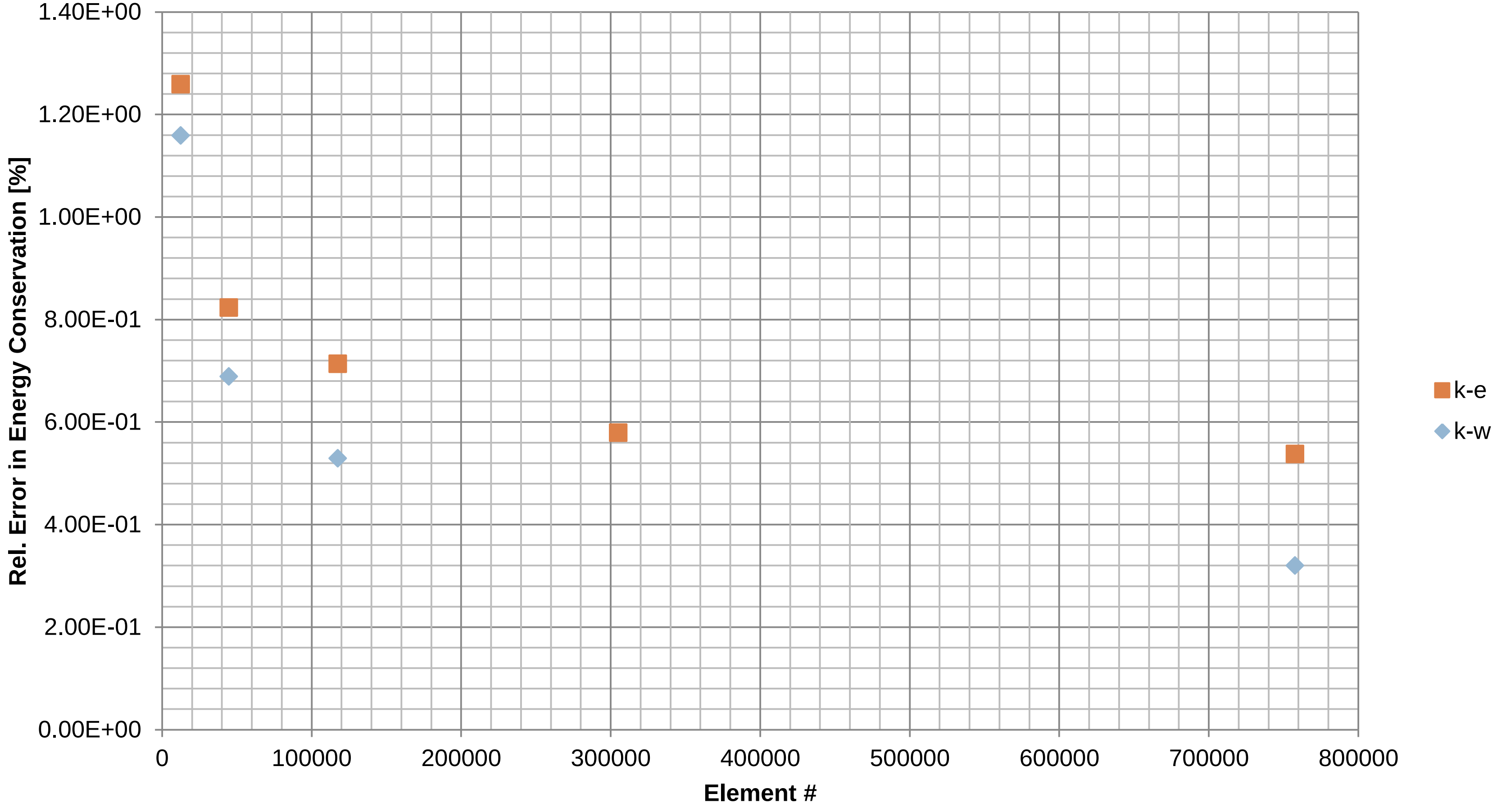
Clad Surface Temperature Comparison Between the SSHTC Results and COMSOL Simulation



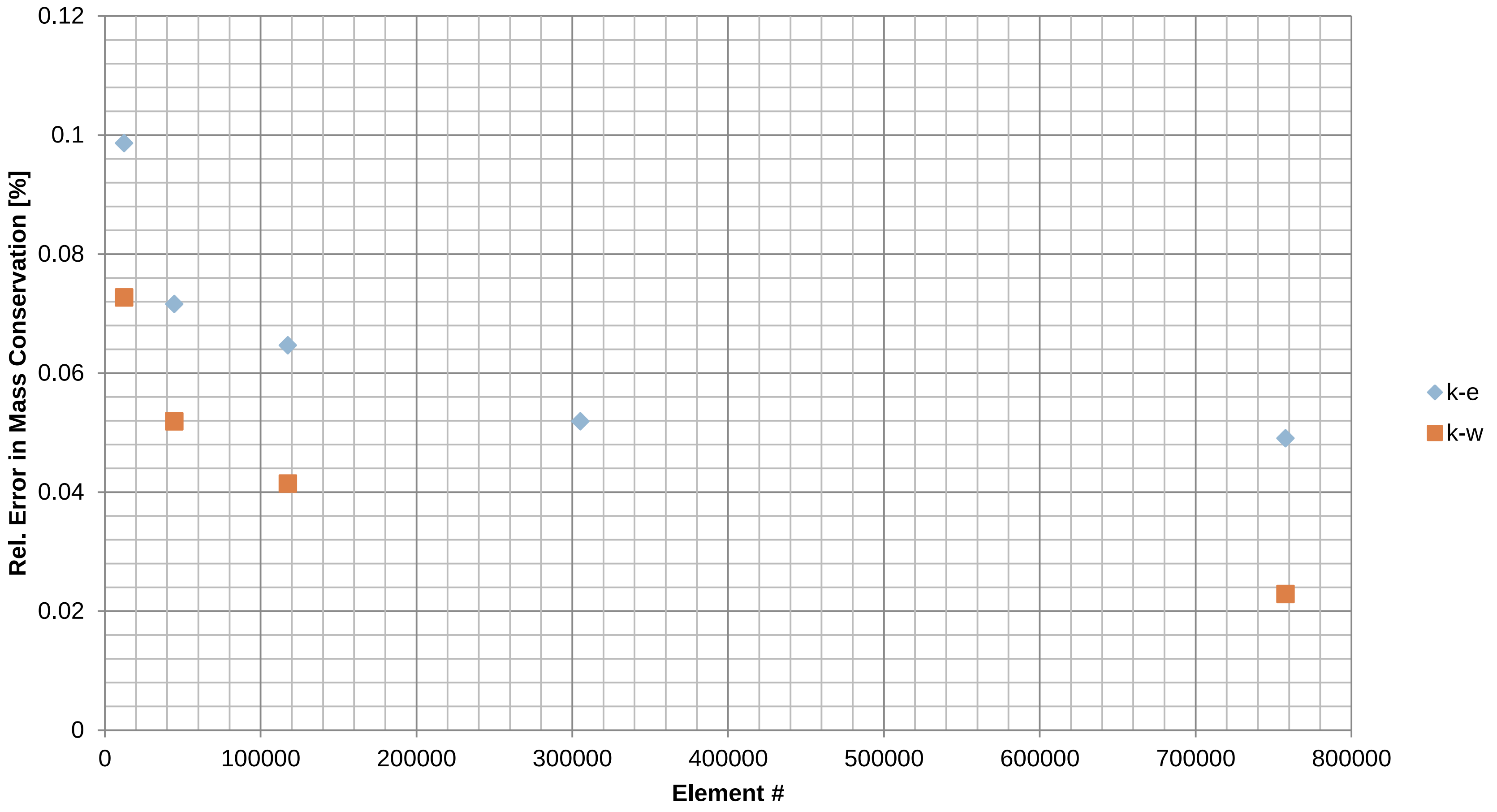
2D Thermal-Hydraulic Constraint Relaxation Geometry



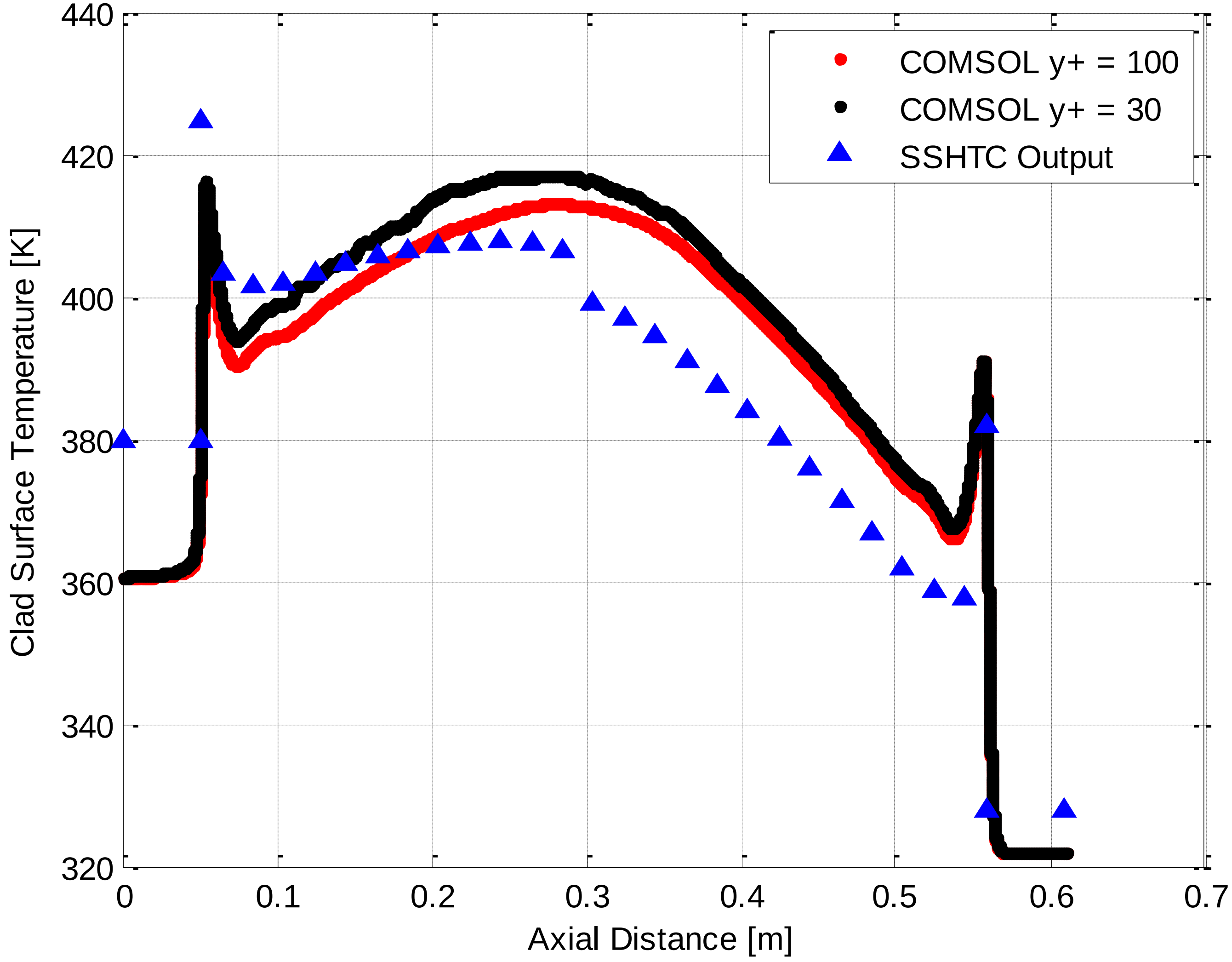
Relative Error in Energy Conservation



Relative Error in Mass Conservation



Overlay of COMSOL Best Estimate and SSHTC Results



Conclusions

- COMSOL adequately reproduces the results of the SSHTC.
- A more physically accurate representation of the thermal-hydraulic processes present in the HFIR core can be simulated using the COMSOL environment.
- k-ω Reynolds Averaged Navier-Stokes (RANS) closure model outperforms k-ε for this problem.
- The dependence of the clad surface temperature on the value of y^+ used in the logarithmic wall function makes the results of the model slightly equivocal.