SAND2017-5087R

Flowfield Comparisons: Tunnel 9 Case 3745

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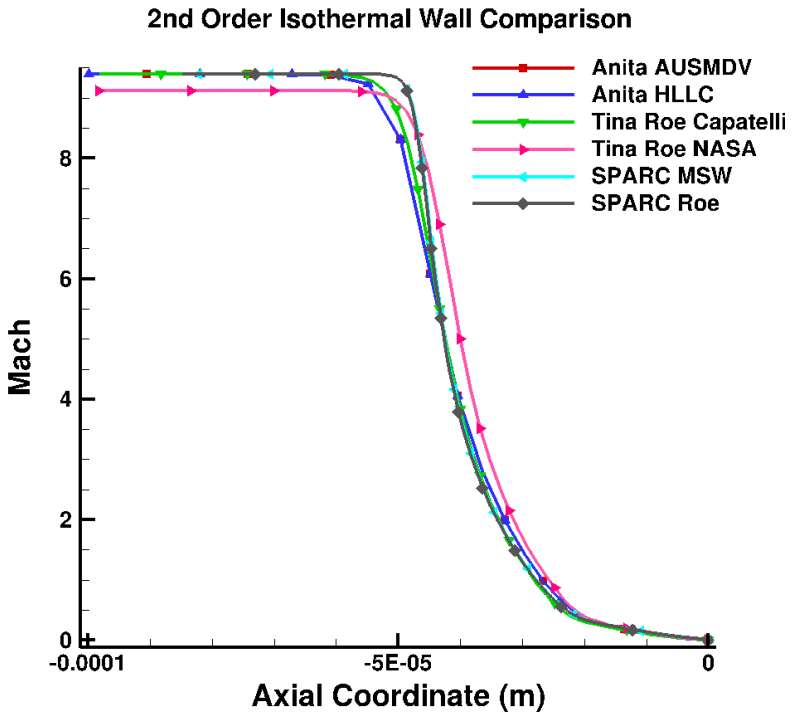
Tunnel 9 – Run 3745

- Conditions and geometry from AIAA-2014-3108
  - $T_\infty = 54.42\ K; \rho_\infty = 4.861123e-3\ kg/m^3; U_\infty = 1413.083\ m/s$
  - Sphere cone 7° half-angle, nose radius 0.006 inches

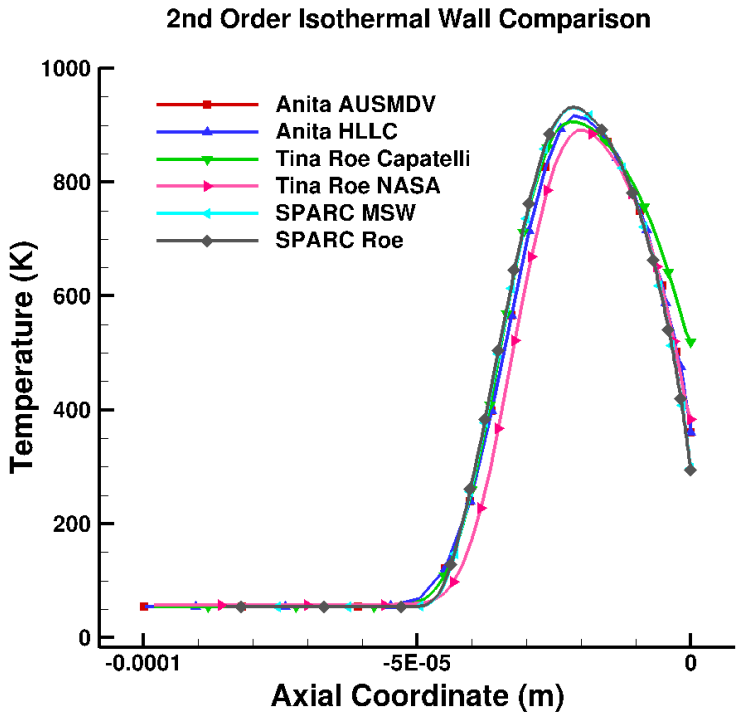
- Sandia Grid
  - 20 cells on the nose; 800 on the body; 200 cells wall-normal
  - Manually shock tailored
- Sandia Computations made with SPARC
  - Cell-centered finite volume using Modified Steger-Warming and Roe inviscid flux schemes
  - Minmod limiter using MUSCL TVD scheme
  - Viscous fluxes evaluated using weighted-least squares gradients

Stagnation Line Comparisons: 2nd Order

Mach Number



Temperature



Stagnation Line Comparisons: 2nd Order

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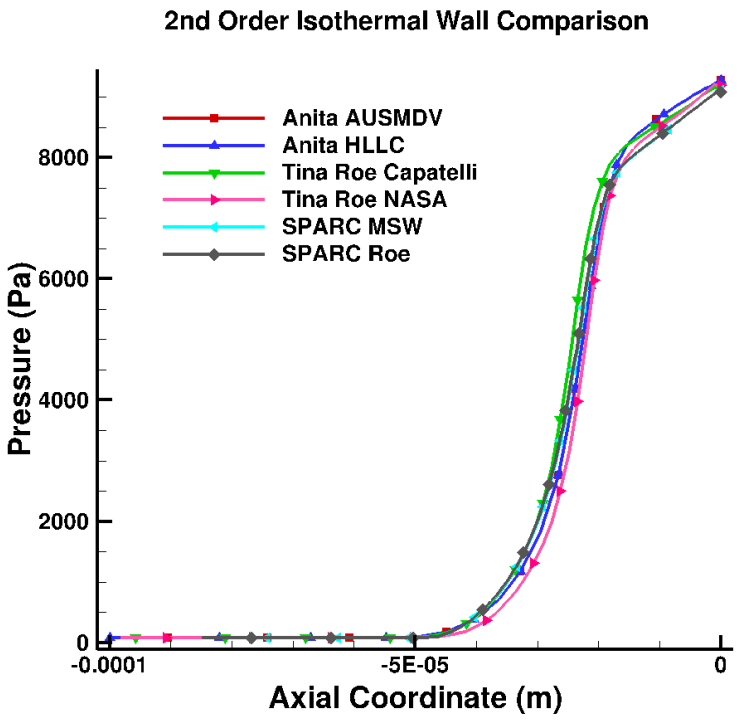
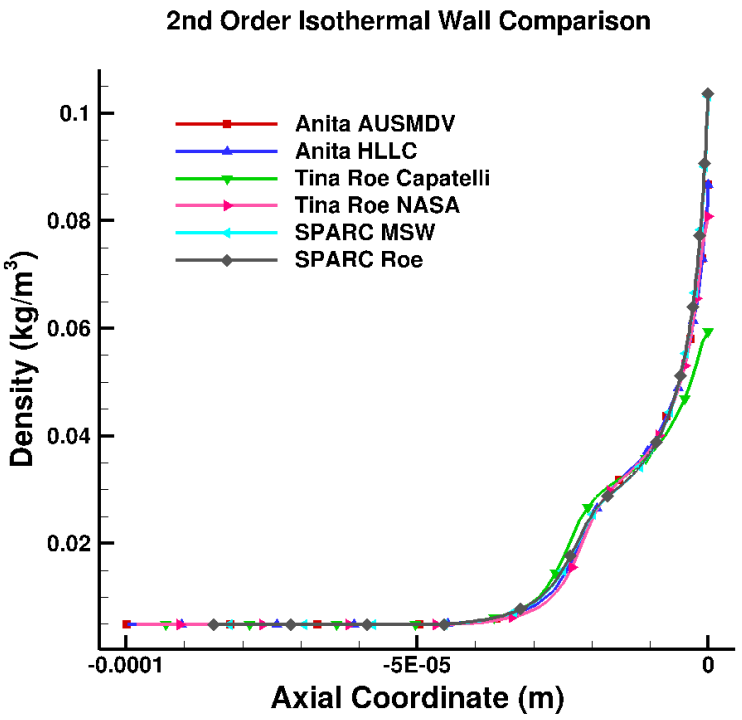
Pressure



Density



Stagnation Line Comparisons: 2nd Order

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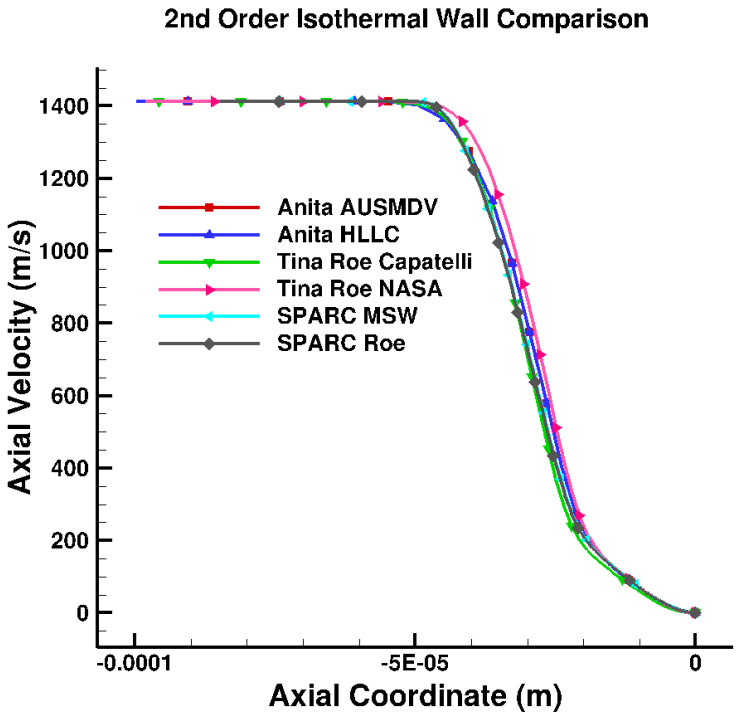
Velocity



Stagnation Line Comparisons: Adiabatic

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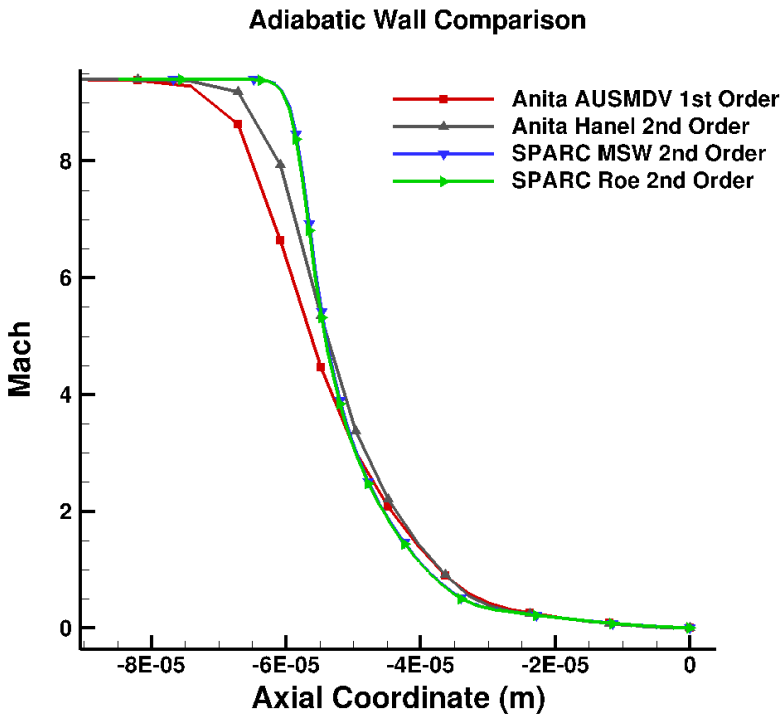
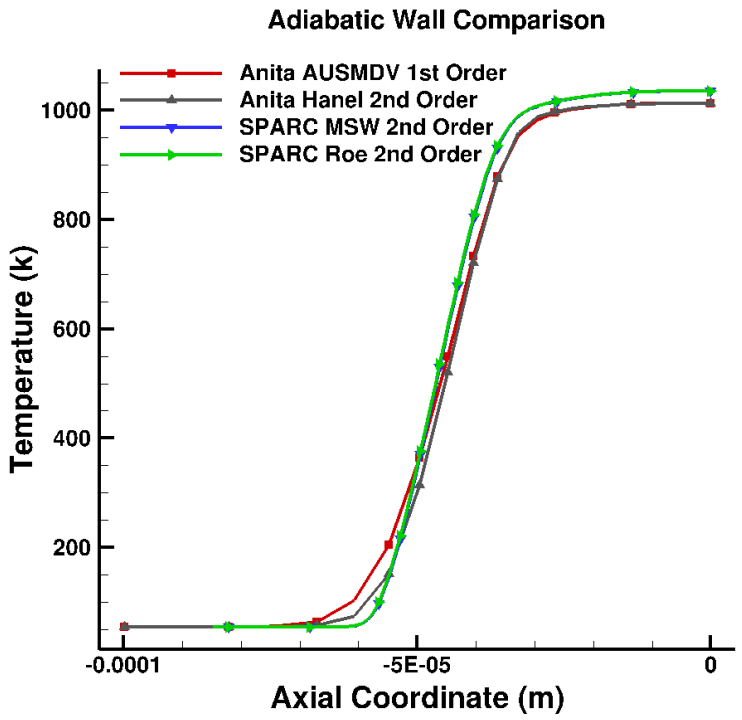
Mach Number



Temperature



Stagnation Line Comparisons: Adiabatic

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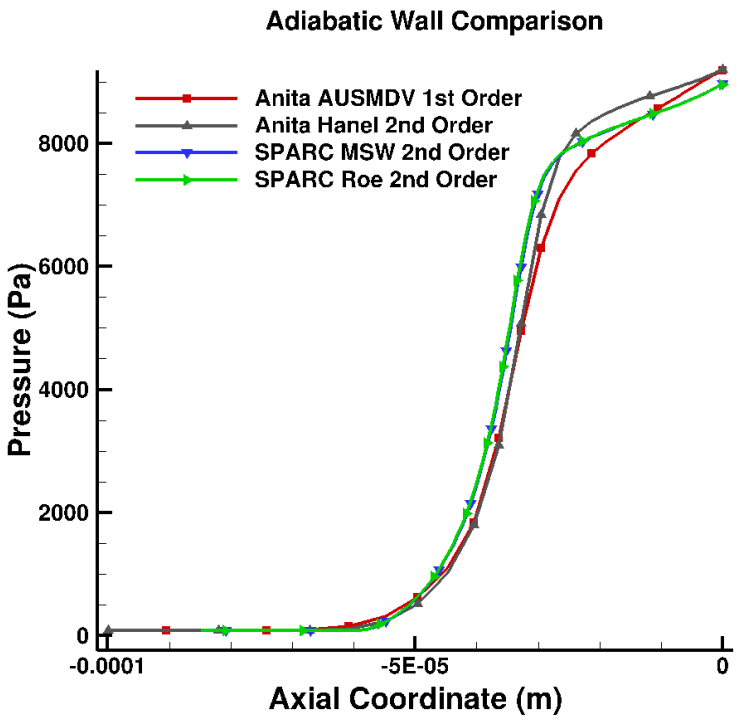
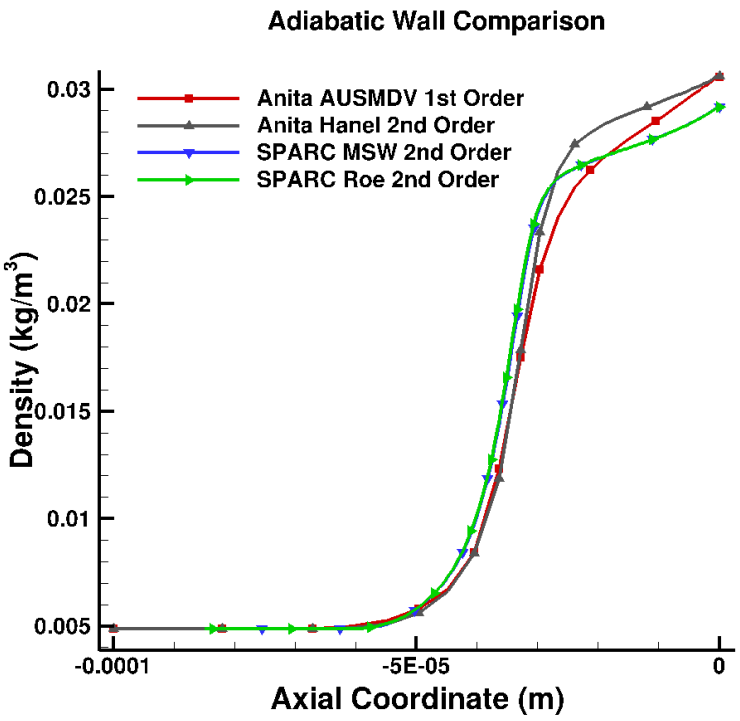
Pressure

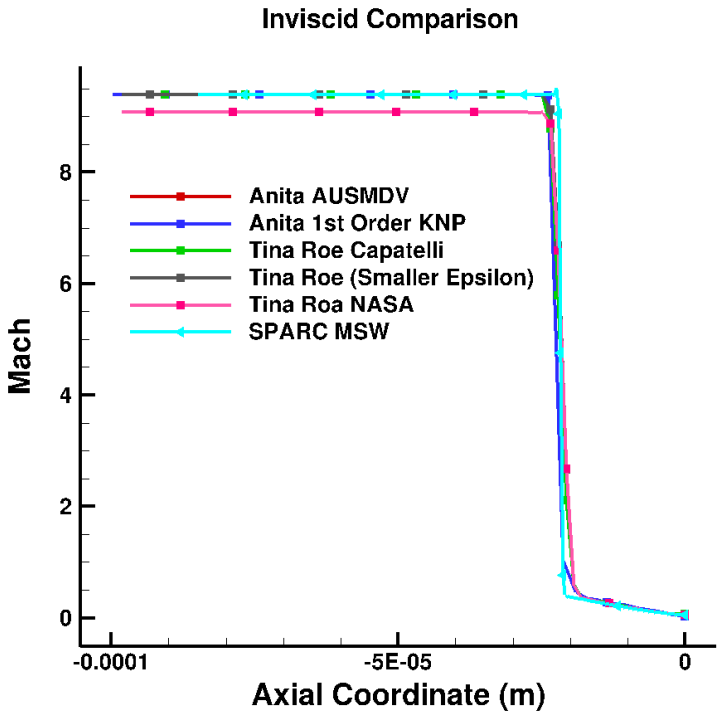


Density



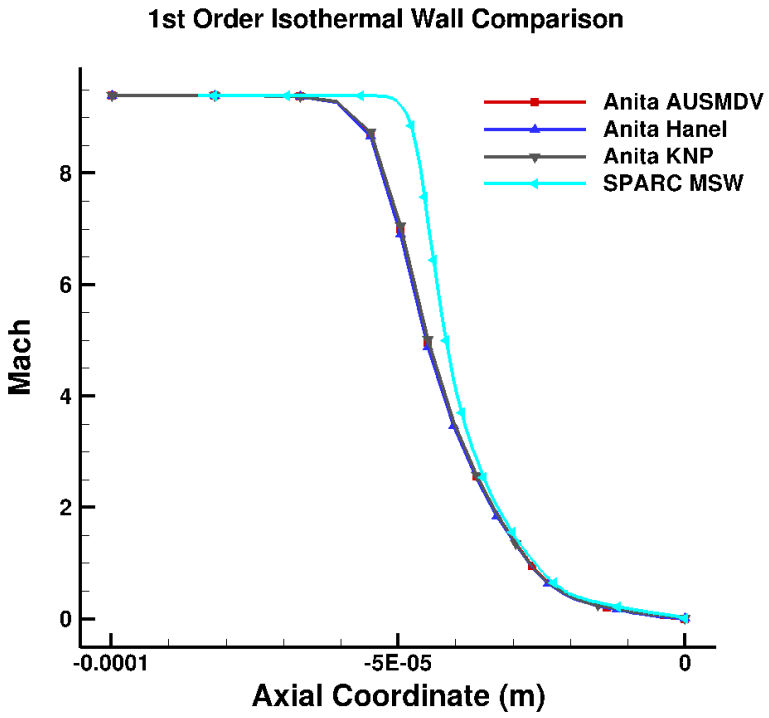
Stagnation Line Comparisons: Inviscid

Mach Number

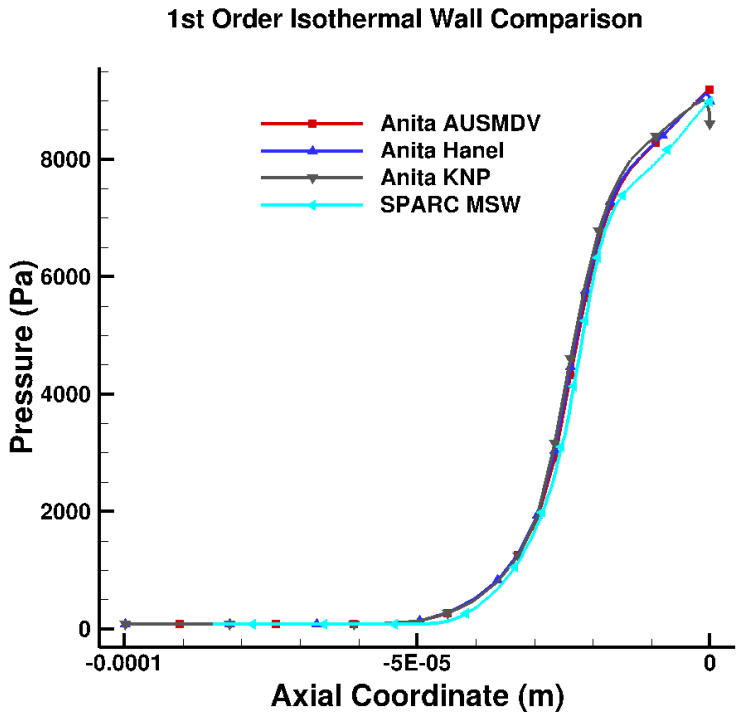


Stagnation Line Comparisons: 1st Order

Mach Number

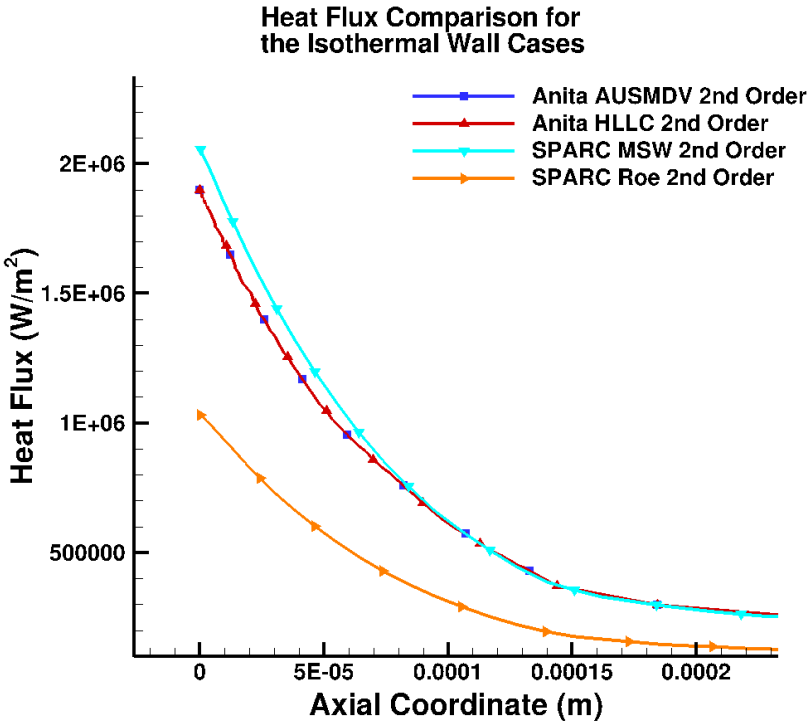


Pressure

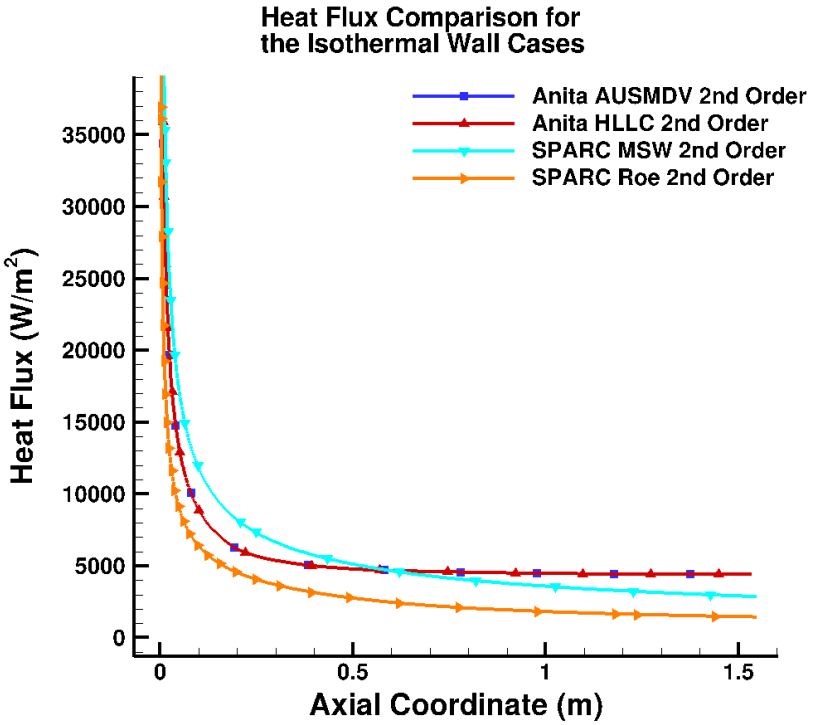


Surface Heat Flux Comparisons: 2nd Order

Nose

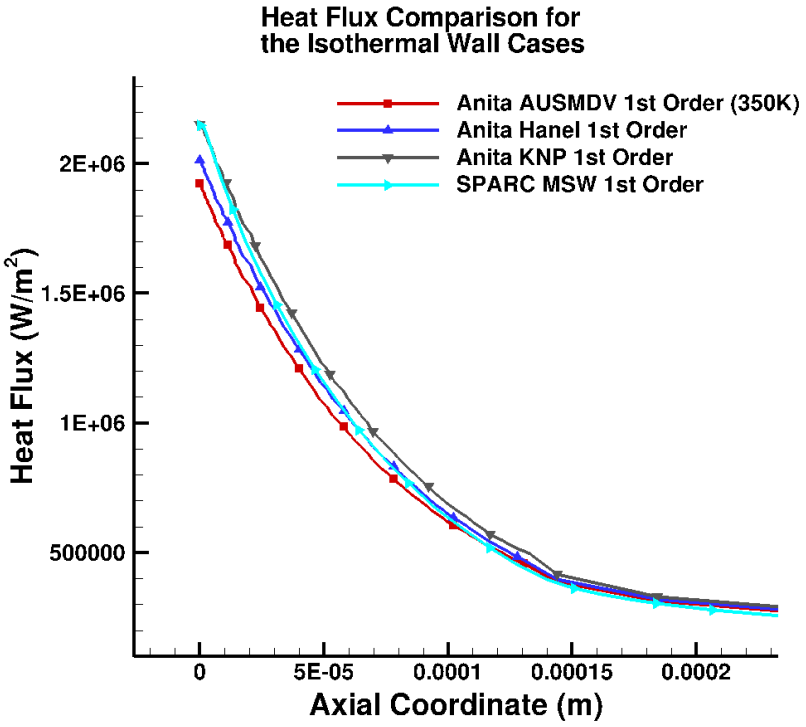


Full Vehicle

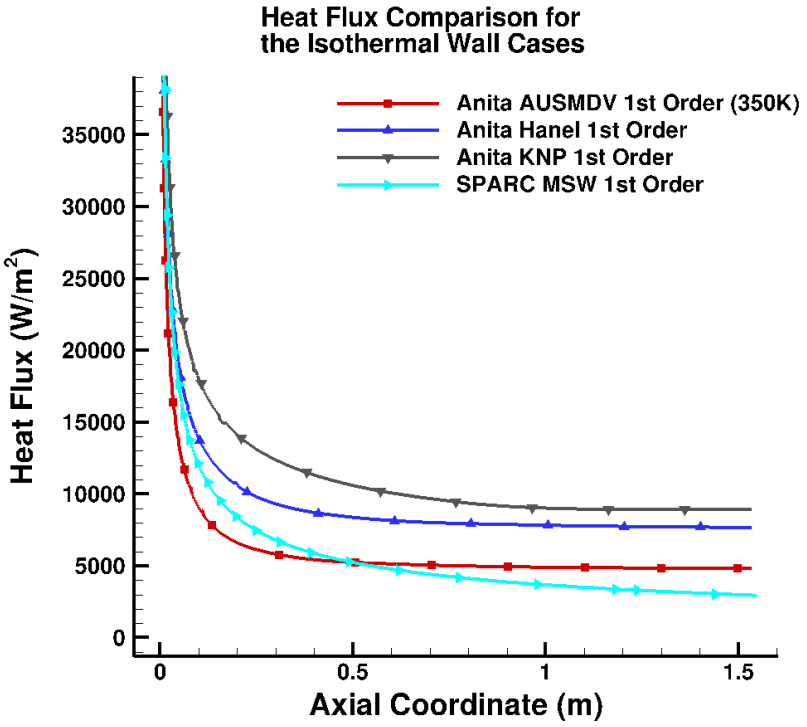


Surface Heat Flux Comparisons: 1st Order

Nose

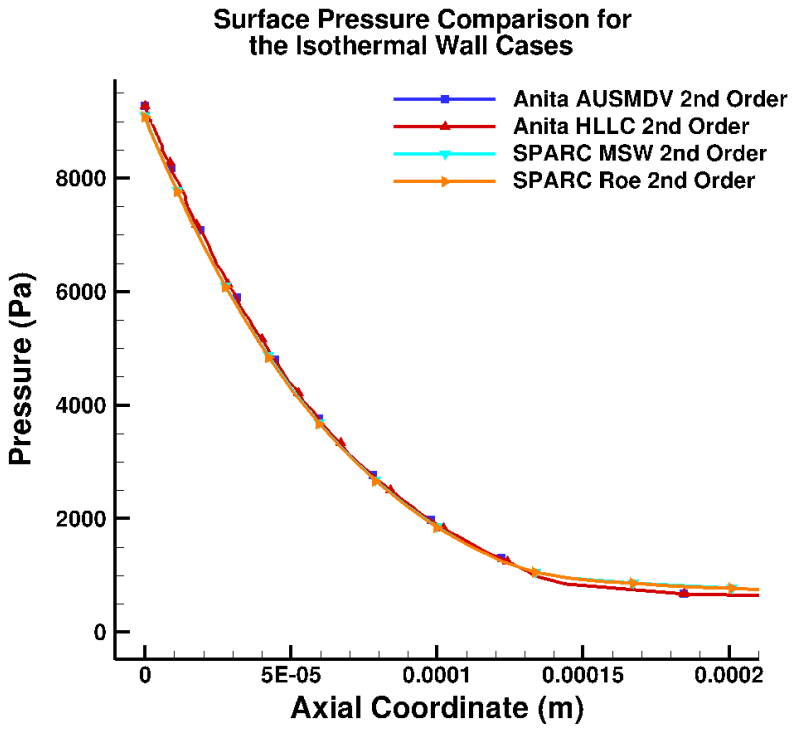


Full Vehicle

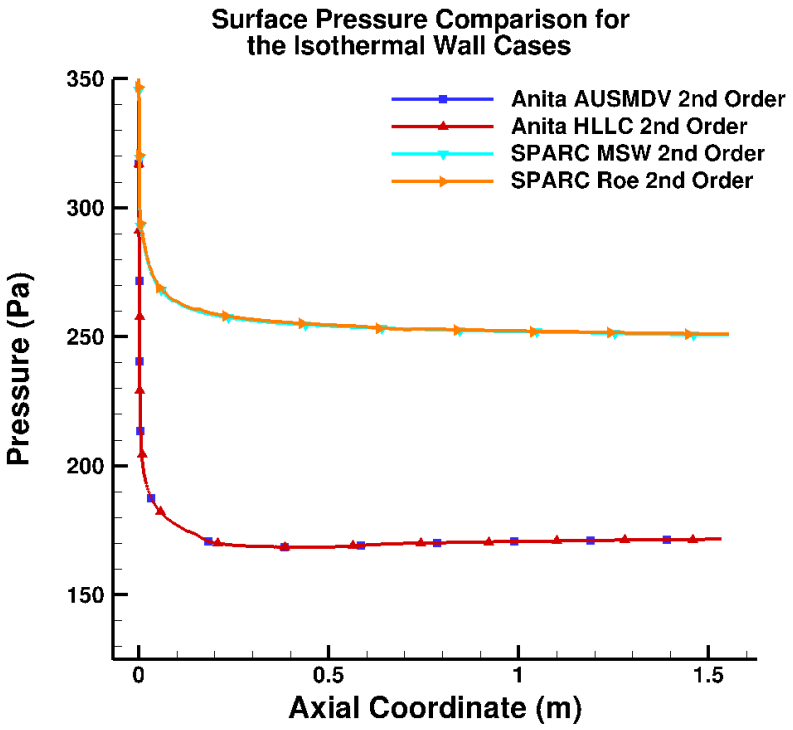


Surface Pressure Comparisons: 2nd Order

Nose

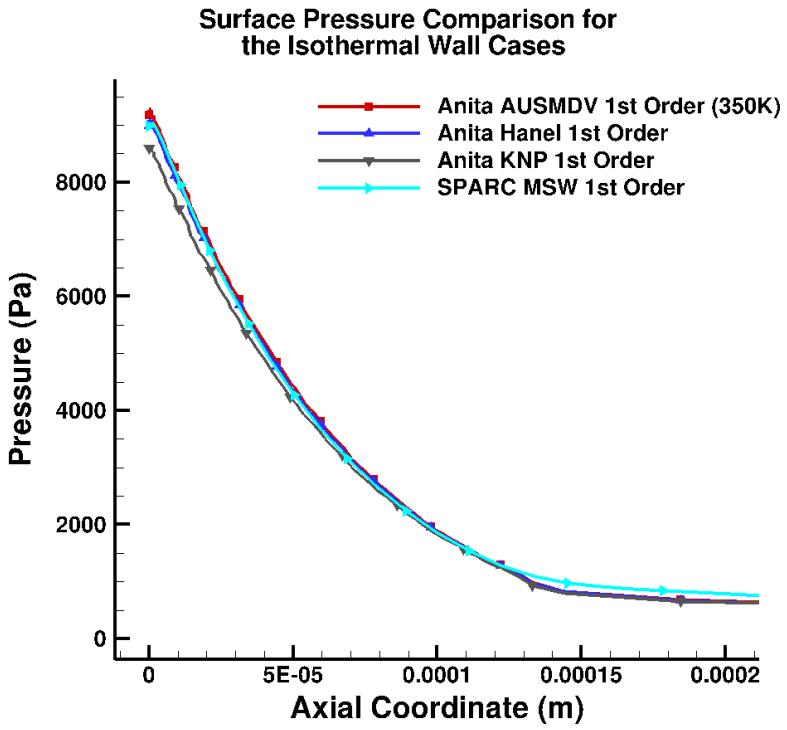


Full Vehicle

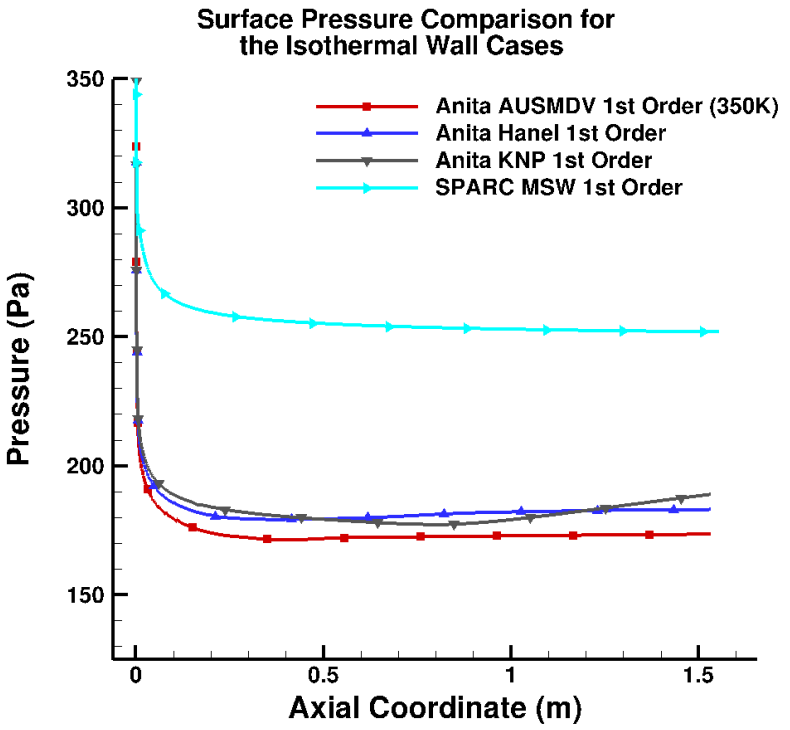


Surface Pressure Comparisons: 1st Order

Nose

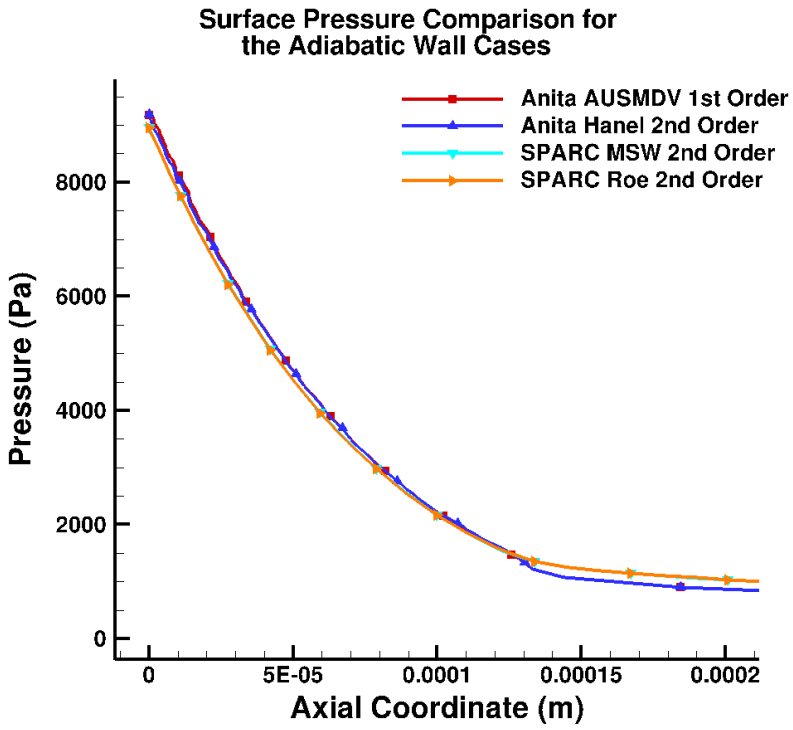


Full Vehicle

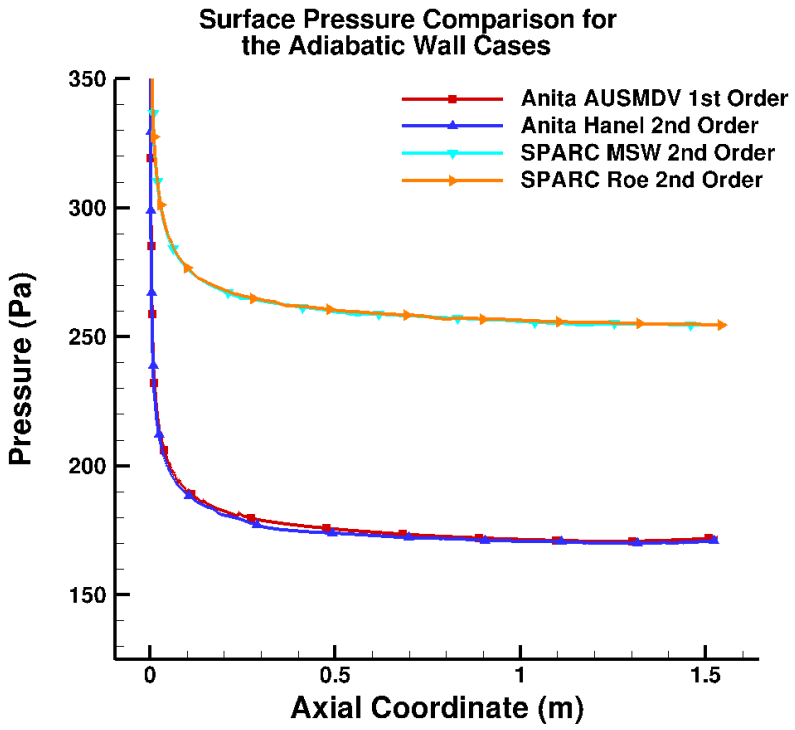


Surface Pressure Comparisons: Adiabatic

Nose

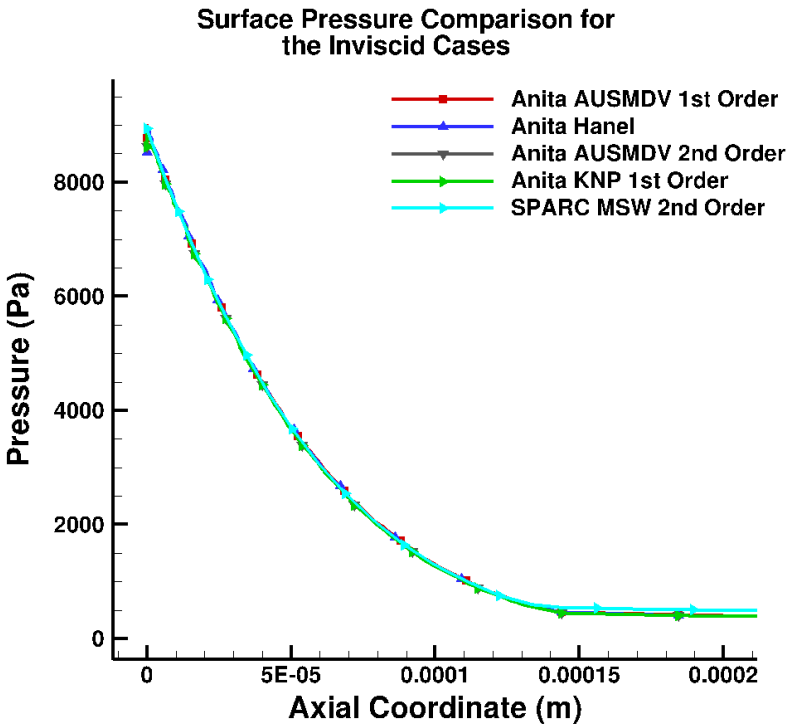


Full Vehicle

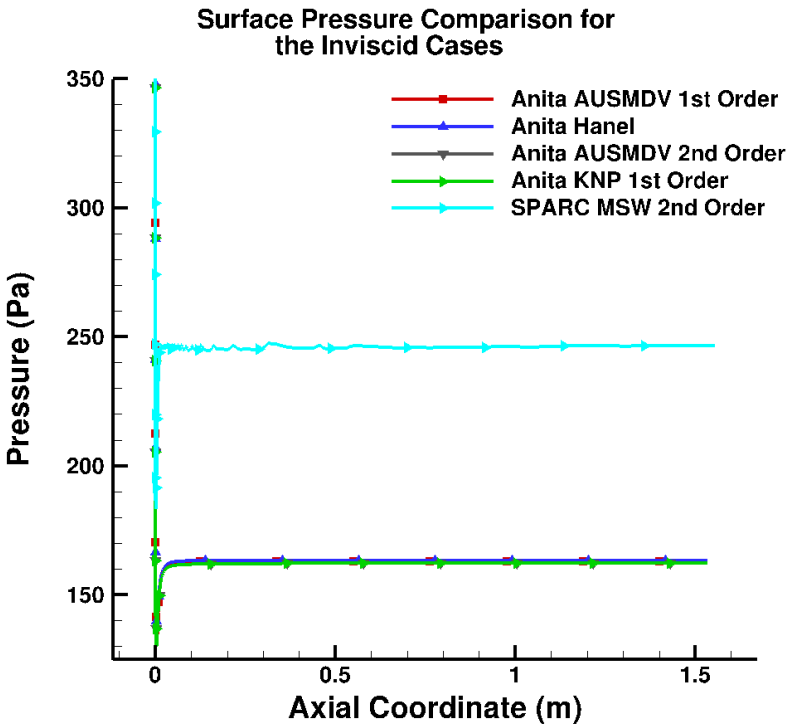


Surface Pressure Comparisons: Inviscid

Nose



Full Vehicle



Initial Conclusions

- Stagnation line comparisons
  - All codes are very similar – outliers are Tina Roe Capatelli and Tina Roe NASA (density and Mach plots)
- Surface comparisons
  - Nose comparisons are very similar – outlier SPARC Roe
  - Full vehicle comparisons show differences
  - Heat flux
    - SPARC MSW and SPARC Roe distinctly different
    - SPARC has slightly different heating trend compared to Anita
  - Pressure
    - All codes predict similar pressure on the nose
    - Frustrum pressures within each code are all very similar
    - Between codes the pressure differs significantly
- Wind tunnel data update
  - Data originally marked as export controlled and are currently being reviewed for release.