InSight’s Reconstructed Aerothermal Environments

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How Did Flight Compare to Design?

• Peak heat fluxes during entry were enveloped by the max heat rate (MHR) design environment, and comparable to the max heat load (MHL) design trajectory fluxes.
• Integrated heating was within design envirion.
• The main seal combined max heat flux was significantly lower than design with 10° AoA.
• As expected, radiative heating computed for afterbody locations on the aeroshell is of the same order as the convective heat flux.

InSight Aeroshell Heritage and Challenges

• InSight was intended to be a Phoenix Lander “Build-to-Print” aeroshell
• Identical aeroshell Geometry
• Same TPS materials with thickness increases only where required.
• Initially, InSight convective heating environments exceeded Phoenix values:
  • Phoenix peak q̇ = 70 W/cm²
  • InSight peak q̇ = 84 W/cm² (2016 launch date)
• Increased analysis complexity for InSight

Convective Heating

• Aerothermal reconstruction computations performed with a combination of DPLR v4.04 and LAURA v5.5 solvers.
• 8-species, non-equilibrium Mars chemistry with super-catalytic, radiative equilibrium wall boundary.
• Total of 16 axisymmetric (0° AoA) solutions at 12 unique trajectory times on BET for comparison to InSight design environments
• Two solutions at reconstructed AoA for main seal heat flux assessment
  • 10° design case drove maximum flux conditions at this location.
  • Non-zero trim angle-of-attack was observed in trajectory reconstruction

Radiative Heating

• InSight radiative heat flux peaks at all locations approximately 110 to 115 seconds from entry interface. Radiative heat pulse significantly lags forebody convective heat pulse but adds to afterbody heat pulse.

Comparison of radiative flux at main seal for both 0° and 4.9° AoA indicates little impact of flight dynamics on main seal environment. Stagnation point and chute lid are even less sensitive to AoA due to view factor.

InSight Entry Reconstruction

Peak Convective Heat Fluxes

InSight Entry Reconstruction

Peak Radiative Heat Fluxes

InSight Entry Reconstruction

Combined Heating Compared to Design

Image Courtesy of NASA

* Flight environments are computed using an InSight reconstructed trajectory, as described in IPPW2019 “Mars InSight Trajectory and Atmosphere Reconstruction”