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Author: Dr. Ciro Borriello
Aviospace S.R.L, Italy, ciro.borriello@aviospace.com

Dr. Gabriele Trani
Aviospace S.R.L, Italy, gabriele.trani@aviospace.com

EXOMARS HEPA FILTER MODELING AND MARS ENTRY THERMAL ANALYSIS

Abstract

HEPA filter is foreseen to be inserted on the ExoMars back shell of the EDM. It will have to face the high temperatures expected during Mars entry phase and it will act as pressure balancer, in order to avoid bioburden and particulate contamination during launch, entry and Mars surface mission phases. In particular it constitutes:

- A permanent bio barrier to prevent the dirty air entering inside the EDM during test and launch operations.
- A permanent bio-barrier to exclude the bioburden of the ESP and RM items that cannot be sterilized. It is foreseen to locate these items in boxes sealed with HEPA filter.

The present study is aimed to perform transient and steady state thermal analysis of HEPA filter (with the use of ESATAN-TMS) and to confirm that temperature ranges allow it to preserve structural integrity and performance in the expected internal and external environments. Attention has been focused on some critical points where thermo-structural requirements had to be accomplished:

- Contact between HEPA filter structure and TPS.
- Internal junctions between different materials.

Different entry strategies and approaches were investigated and it was possible to conclude that HEPA filter showed a positive behaviour and response to Mars entry heat fluxes. In particular the maximum temperature reached at the end of transient on the upper disc, directly in contact with TPS, was below the 180 C requirement. Sensitivity analysis still confirmed this behaviour.

The other interesting focus was made on thermal gradient in the Titanium-Medium junctions. In this frame the maximum value, obtained during the analysis, was reached for the Shallow entry condition, with the maximum value of fluid thermal conductivity.

Moreover, sensitivity analysis pointed out that other influencing parameters were linear conductors. In particular, lower values lead to higher thermal gradients in different materials junctions, while almost no correlation was obtained for upper disc maximum temperature, most exposed to entry thermal fluxes.

Both baseline thermal analysis and sensitivity have been carried out considering a static CO2 fluid through HEPA filter cavities. If this assumption falls apart it can be interesting to note that no particularly higher thermal gradient in the junctions was reached, while a far higher upper disc maximum temperature of about 190 C went beyond the fixed requirement of 180 C.