Morpheus Support and Secondary Vehicle Development

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Introduction

The Morpheus vertical test bed was designed and build in at the Johnson's Space Center to demonstrate capabilities of propulsion systems using LOX/LCH4. Some other technologies being explored and developed include autonomous landing and hazard detection technology. Over my summer rotation at the Johnsons Space Center I was tasked with support of the current Morpheus vehicle and build preparations for a second spare vehicle. Work for the spare vehicle included propulsion system design improvements and modifications.

RCS Acceptance Testing

A Reaction Control System using methane and oxygen has been developed by the Johnson's Space Center propulsion branch. After design and development, acceptance testing was required for vehicle integration and testing. Contributions to testing included test build up, data acquisition system trouble shooting, testing and post test data analysis. The acceptance testing allowed the propulsion team to integrate the subsystem to the Morpheus vertical test bed.

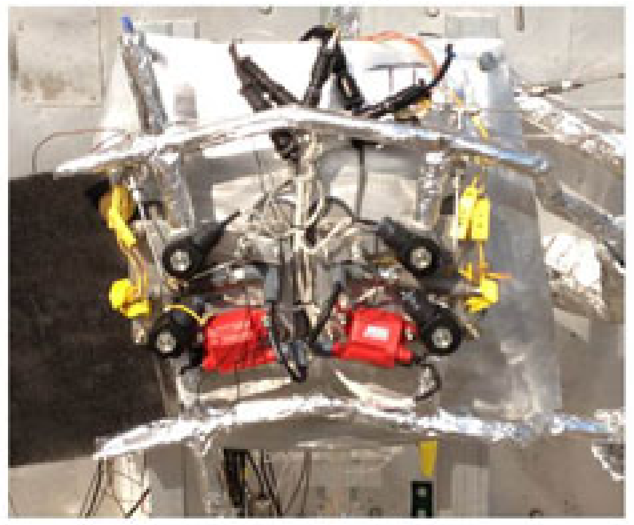

Fig. 1. Photograph of Reaction Control System setup.

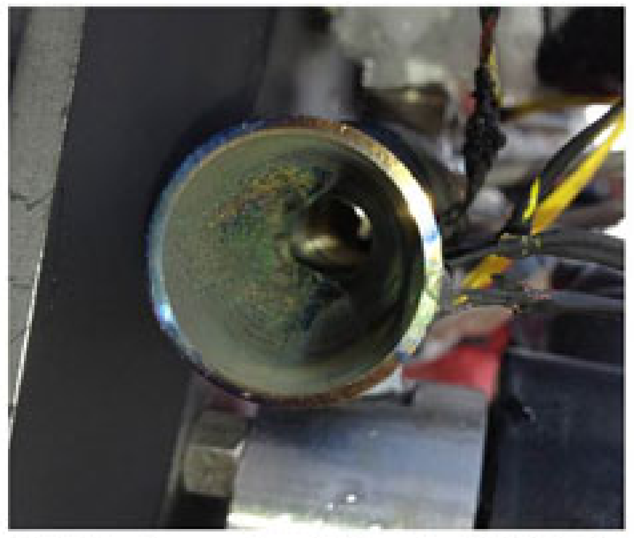

Fig. 2. Photograph of Eroded RCS thruster nozzle taken after a steady state firing.

RCS Testing Data Analysis

The captured during testing included inlet propellant conditions data, chamber pressures, chamber temperatures, nozzle temperatures. During this testing a witness plate was used to captured the heat plume created by the left thruster.

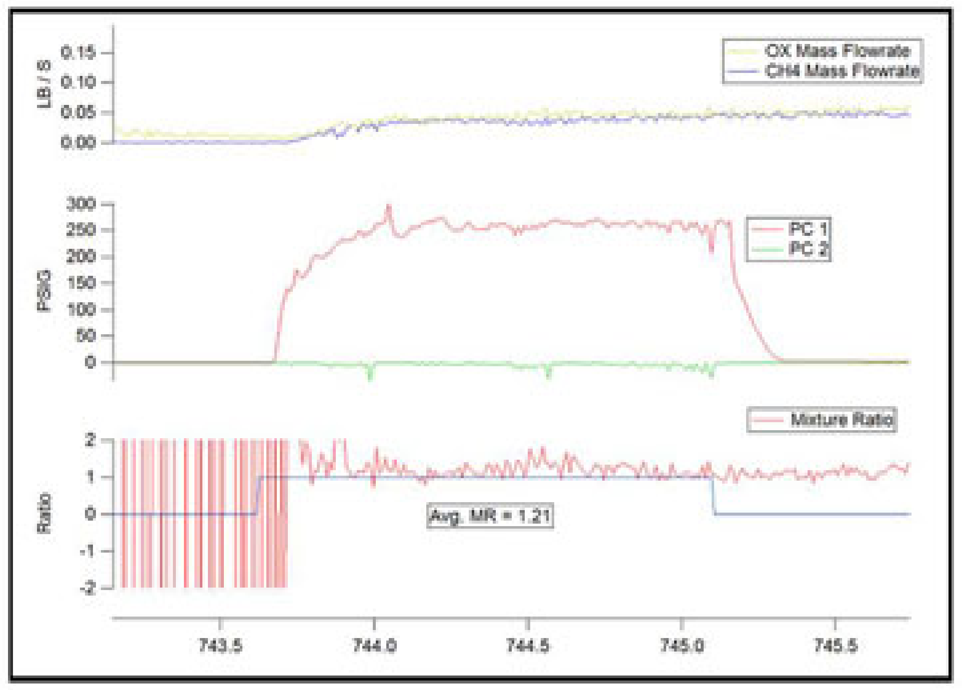

Fig. 3. Screen shot of, Mass Flow Rate, Chamber Pressure, and Mixture Ratio Vs. Time

Vehicle Filter Background

Pressure drop across any system is important and in most systems unwanted. In propulsion systems a high pressure drop across the propellant delivery system affects performance. In the Morpheus propellant delivery system a large pressure drop occurs mainly across the filtration element. The vehicle utilizes conical filters that protect engine component such as the injector plate form contaminate inside the cryogenic propellant. Pressure drop across filter had to be decreased

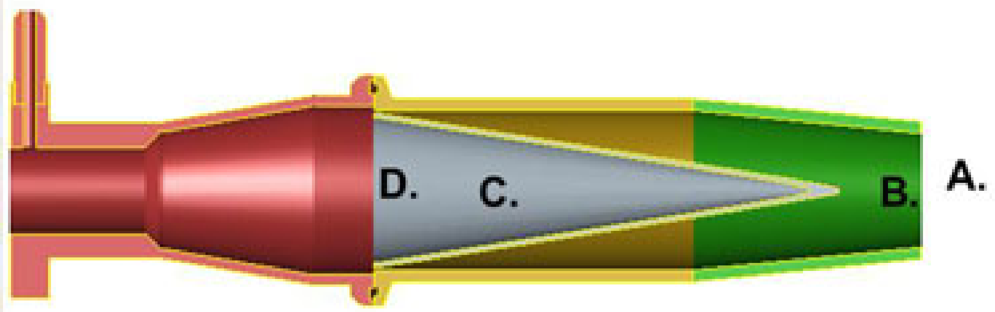

Fig. 4. Morpheus Propellant Delivery System Conical Filter. **A.** Incoming Flow, **B.** High Pressure, **C.** Filtering Element, **D.** Low Pressure

Filter Modification Approach

Pressure drop reduction across the filtering element was approached systematically to assure an effective redesign The conical filters consist of a stainless steel perforated support and a stainless steel filtration mesh. These two components of the filter had to be analyzed and a baseline support and mesh specification had to be established.

Mesh & Support Modification

The pressure drop across the filter comes form the reduction in area that is necessary for filtration. Both the support and filtering mesh have a corresponding open area percentage and larger this area is the lower the pressure drop. To maximize the open area, modifications to the filter support were made and the open area was increased. A different mesh was used to construct the filter giving us lower a pressure drop.

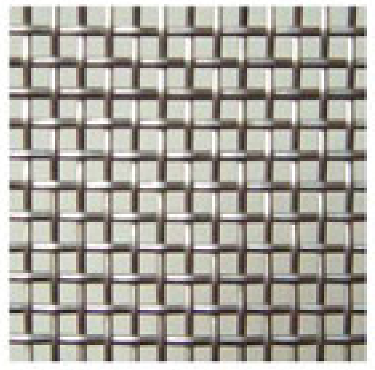

Fig. 5. Photograph of a steel filter mesh.

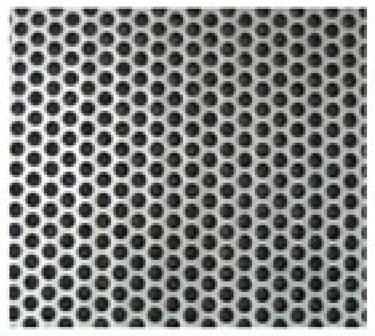

Fig. 6. Photograph of a steel filter support.

Testing

To better understand the effects of both mesh and support modifications, incompressible flow testing was conducted. The test setup consisted of a varying water source that flowed water at room temperature through the filter. During testing, upstream and downstream pressures as well as flow rate data was captured. This data was able to quantify the improvement over the previous filer.

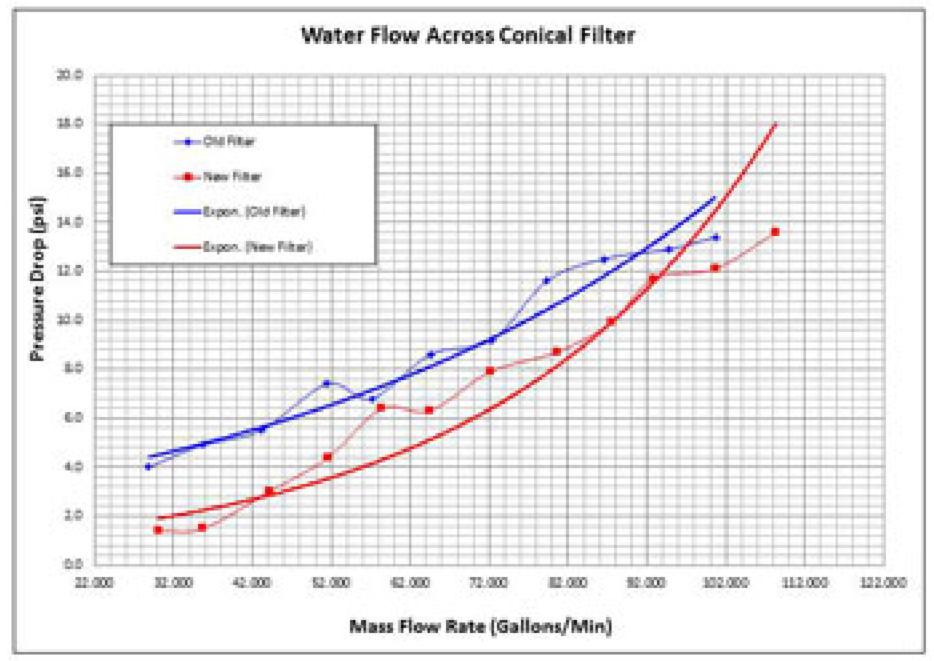

Fig. 6. Plot of water flow across Conical Filter, comparing the original vehicle filter and the redesigned filter pressure drop at different flow rates.

Conclusions

In Conclusion the pressure drop across the filter was improved by modifying both the mesh and support elements of the filter. By increasing the open area percentage of the filter the pressure drop can be decreased , but unfortunately current mesh products are limited for the desired particle size. The support open area can be increased but careful consideration has to be given to the mechanical integrity of the filter.

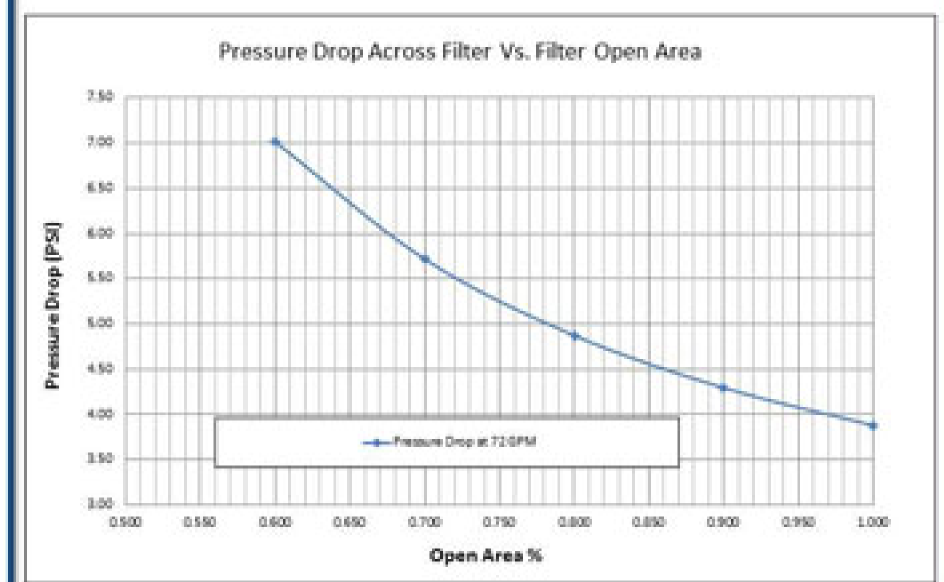

Fig. 6. Plot of theoretical pressure drop across filters for varying open area percentage at 72 GPM

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