Summary of Martian Dust Filtering Challenges and Current Filter Development

William J. O'Hara IV

NASA Johnson Space Center

Mars Dust Workshop: June 13, 2017

Outline

Goal: Not to present a design solution, or new revelation in requirements, but to highlight the challenges and progress in developing a filter as we spend time discussing the properties and the potential hazards of Martian dust

Outline:

- Dust Filtering Applications
- Key Design Requirements
- Filter Design Progress
- Summary

Dust Filter Applications

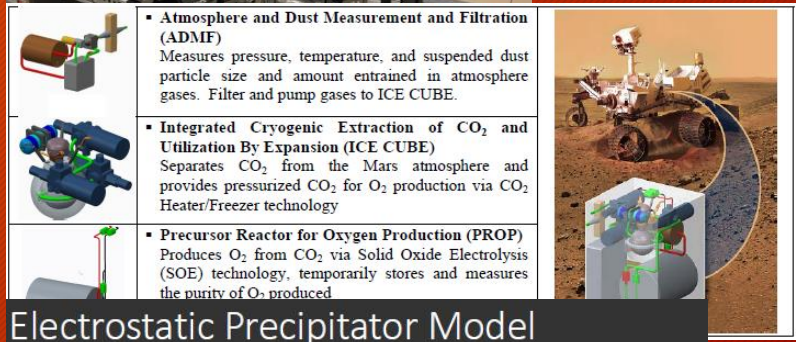
- In-Situ Fuel Production Systems
  - Single point failure of entire mission if inlet becomes clogged
  - Stand-alone, maintenance free, long term operation
- Manned Systems
  - Airlock Pump Down Systems
  - Habitat and Pressurized Rover ECLS Systems
  - Habitat O2 extraction from Martian Air
- For manned systems, maintenance (filter cleaning or replacement) is a possibility, however
  - Requires Crew Time
  - Requires up-mass for spare parts like filters unless filters can be regenerated/cleaned by crew
  - Design complexity and mass can be driven into system to enable maintenance

Key Driving Requirements

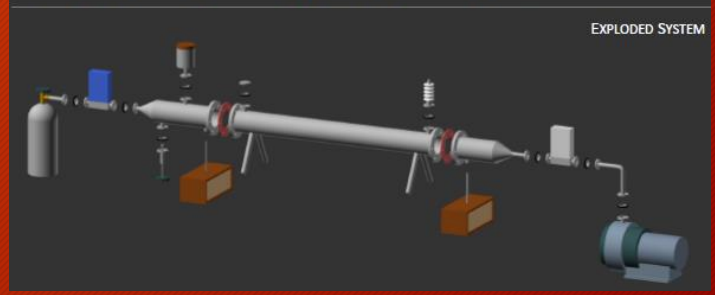
- Reliability: This is key for ISRU Fuel production during long periods of time without the presence of crew and the ability to do maintenance
- Maintainability: Must not be time intensive for manned systems, but is a trade off with mass and volume
- Volume, Power and Mass: Filtration systems using dedicated fans or pumps will increase all three
- Load Rate Capability: Difficult to quantify for all systems, and highly variable for ISRU systems and airlock systems. MER data has provided some estimates in airborne dust per unit volume.
- Load Characteristics: Some estimates have been made for airborne particulate, but EVA suits and tools will pick up larger particles. Dust storms, ascent and descent engine plumes will load the air as well.
- Working Environment: Low CO2 Atmosphere density is a challenge for systems developed so far

Filter Design Progress

- NASA GRC Closed-loop Air Flow Test Bed Development (2015)
  - Closed air circulation Loop design to test different filter media
- NASA KSC Electrostatic Precipitator Development (2011, 2016)
  - Found better performance than expected in the low density air of a simulated Martian atmopshere.
- Mars 2020 MARVIN Atmosphere Dust Measurement and Filtration (ADMF) subsystem development
  - Will measure and quantify amount of ingested dust as well as impact to ISRU system from using filtered and unfiltered air
  - May test HEPA and ESP Filters



Electrostatic Precipitator Model



Summary

- High level glance at a difficult design challenge
- For ISRU systems in particular, the need for a reliable, maintenance free dust filtration system is critical
- For other systems it must be balance of maintainability and mass/volume/crew time
- Derived requirements are still vague and difficult to quantify, especially in the absence of a defined mission with derived mass, power, and volume allocations
- Some work has been done at GRC and KSC more results hopefully soon.
- Out in 2020's, we will learn a lot more with the MARVIN experiment.