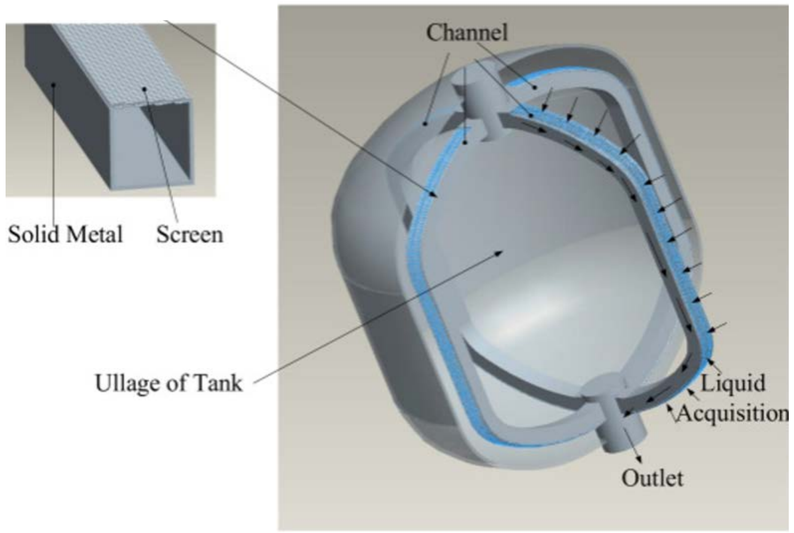
AUTONOMY RESEARCH CENTER FOR STEAHM

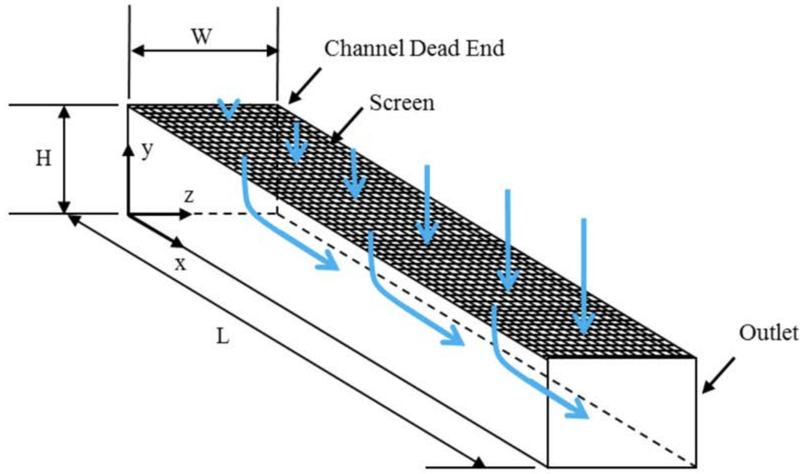
Autonomy for Manufacturing and Construction

In-Space Propellant Tank Venting

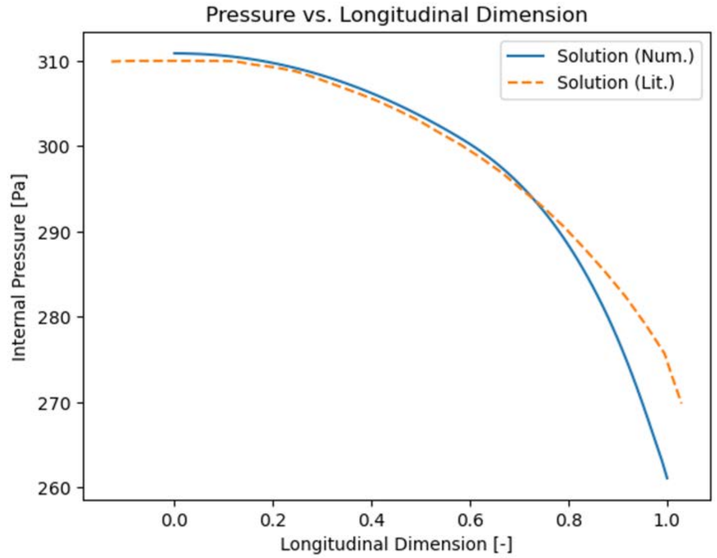
Channel Cross-Section



(1)



(2)



(3)

Synopsis

To achieve a propellant management system capable of retaining the liquid propellant while venting ullage, the following approach is being taken:

- The development of an analytical model to predict the performance of a new type of screen channel liquid acquisition device (LAD).
- Validating the analytical model by comparing it with existing data and computational fluid dynamic simulations.
- Collecting experimental data for new screen channel LAD design.

Research Objective

- The presence of unwanted vapor, known as ullage, in spacecraft propellant storage tanks proves to be an issue preventing deep space exploration.
- The presence of vapor propellant leads to over-pressurization of the fuel tanks onboard and less range of travel.
- The goal of this project is to innovate existing propellant management devices that prevent liquid from being extracted with the ullage.

Research Approach

- Enhance propellant management systems' performance by:
  - **Adding converging and diverging effects to channel.**
  - **Adding varying permeability to the screen via 3D printing**

Research Results and Products

- Image 1 shows a screen channel LAD inside of a typical spacecraft's fuel tank.
- Image 2 shows a concentrated view of the screen channel LAD. It is composed of a screened face on the top, 4 solid walls, and an outlet.
- Image 3 shows the validation of our numerical solution, and the solution provided by literature.

Commercialization and/or Societal Impact Opportunities

- **Application**: In-space propellant transfer.
- **Key Values**: Enhance liquid propellant retention in spacecraft.
- **Potential Customers**: Aerospace industry.

Team Names & Collaborators

- **ARCS Students:** Cole Millett, M.S. Mechanical Engineering; Alejandro Piscione, B.S. Mechanical Engineering
- **Faculty:** Dr. Vinicius Sauer, Assistant Professor, Mechanical Engineering
  Dr. Bingbing Li, Associate Professor, Manufacturing Systems Engineering
  Dr. Nhut Ho, Mechanical Engineering
- **Aerospace Corporation:** Dr. Matthew E. Taliaferro, Dr. Samuel R. Darr, and Dr. Paul D. Lee

Citations

- Jaekle, D.E. "Propellant Management Device Conceptual Design and Analysis: Galleries" AIAA 97-2811, 33rd Joint Propulsion Conference and Exhibit, Seattle, WA, July 6 – 9, 1997.
- Hartwig, J. W. (2014). LIQUID ACQUISITION DEVICES FOR ADVANCED IN-SPACE CRYOGENIC PROPULSION SYSTEMS.
- Jian Li, Yanzhong Li, Yuan Ma, Lei Wang, Fushou Xie, Performance analysis and improved design of screen channel liquid acquisition device for hydrogen, International Journal of Hydrogen Energy, Volume 47, Issue 56, 2022, Pages 23856-23870, ISSN 0360-3199, https://doi.org/10.1016/j.ijhydene.2022.05.202.

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