Hyster-Yale Fuel Cell Degasser

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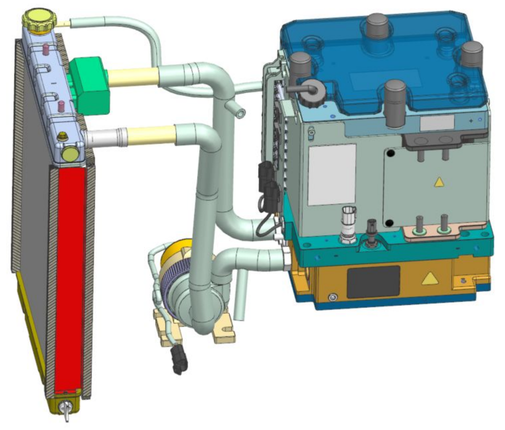
INTRODUCTION/MOTIVATION

As an alternative to the internal combustion engine, hydrogen fuel cells promise higher efficiency and no emissions. But the small molecules of hydrogen fuel can slip between cracks and disrupt other processes, such as the engine's coolant system.

Hyster-Yale Group, a global forklift design company working on a fuel cell engine, requires an automatic hydrogen degassing device to prevent erratic flow of coolant and possible burnout of the cell stacks.

Hyster Yale Hydrogen Fuel Cell Reachstacker



Current Cooling System Model

PROBLEM STATEMENT:

Develop a device to passively remove trapped hydrogen gas within the cooling system. The device should mitigate any gas build up anywhere in the system by preventing gas circulation or gas build ups at local high points.

CORE DETAILS:

- Shall not contain materials that leech ions
- Maintain a pressure between 0.9 - 1.3 bar
- Maintain coolant flow rate of 35 LPM
- Maintain a temperature of 65℃
- Shall not leak coolant.

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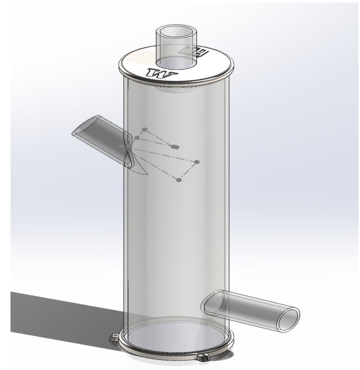
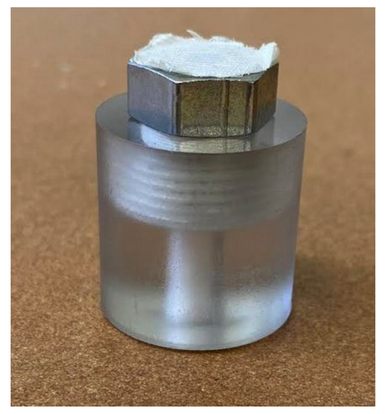
DESIGNS AND DEVELOPMENT

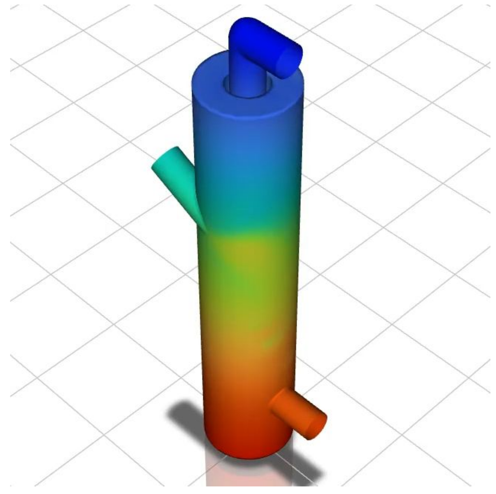
Initial Ideas



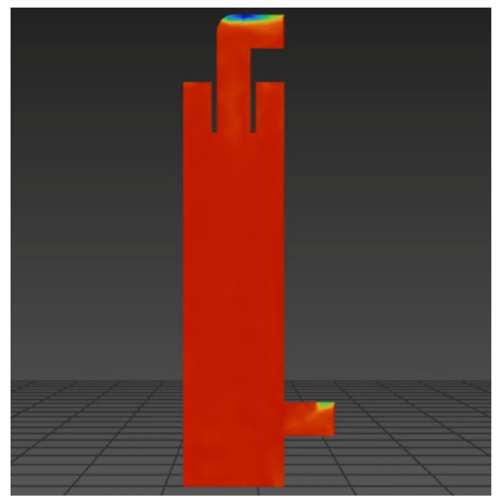


	Bubbler	Cyclonic Separator (CS)	Bleed Screw Membrane (BSM)
Benefits	More compact; Lower risk of success	Maintains better flow rate; No Chemical Compatibility Risk	Allows gas to pass through while containing liquids; Maintains pressure
Constraints	Impedes in liquid flow rate; introduction of external gas variable	Larger size; precise machining required	Fragile; Chemical Compatibility; Pore Size dependent on Pressure

Simulations



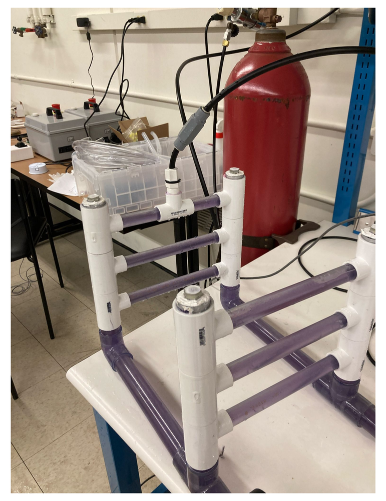
Separator Dynamic Pressure



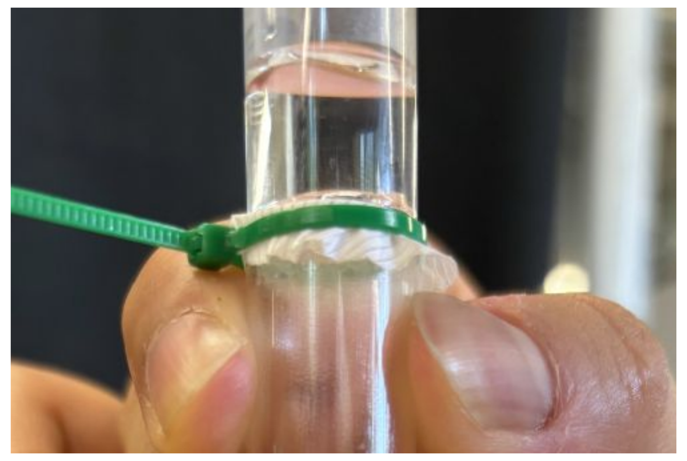
Separator Volume Percent Water FEA

Testing

CS Prototype



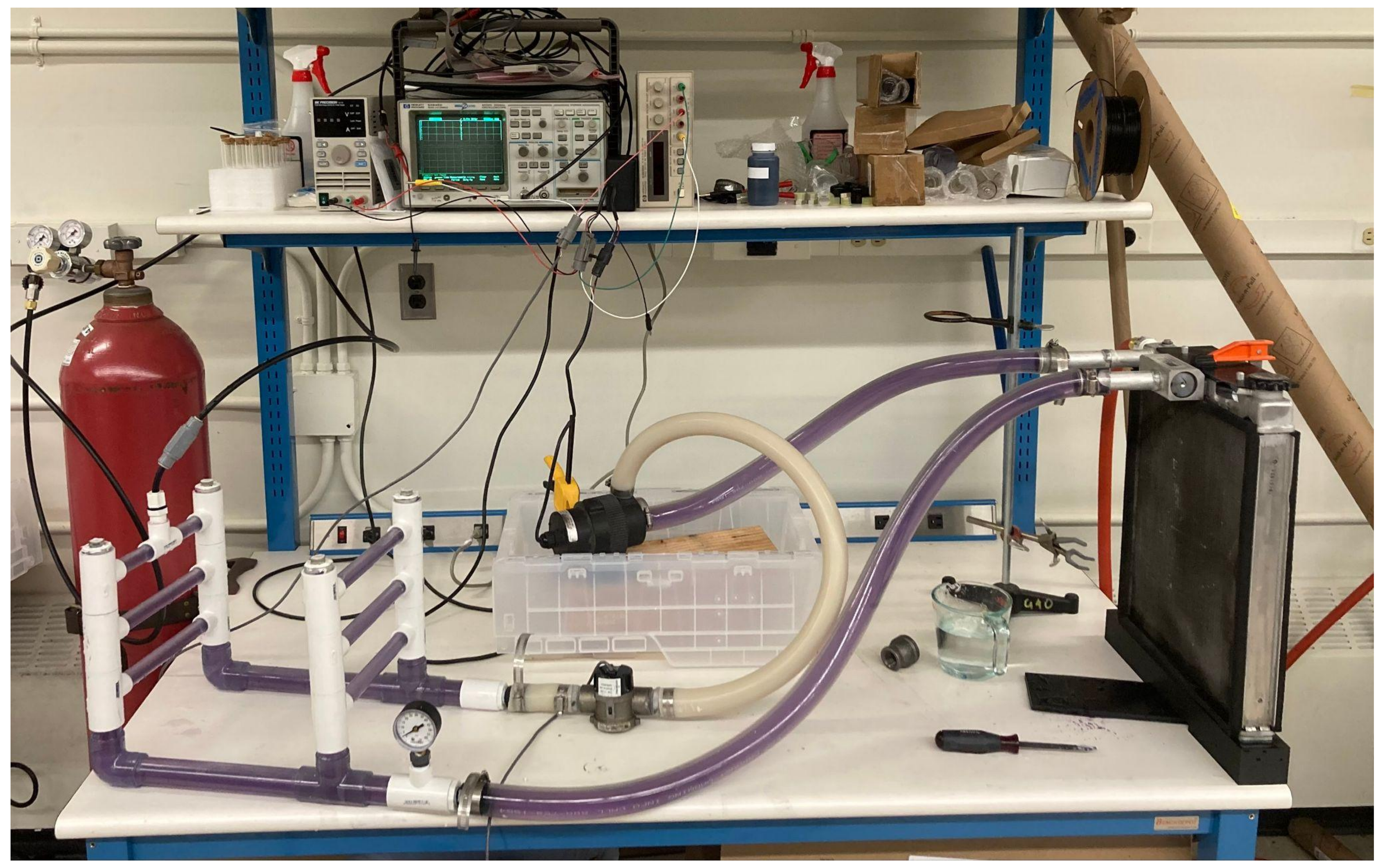
Liquid System Testing



BSM Hydrophobicity Experiment

RESULTS/VALIDATION

After using FEA to validate our models, we built the test bench configuration below to test them. We added 80 mL of helium to the system, observing gas build up in high points.



CONCLUSION & FUTURE WORK

During the design process, machining & design reiteration took the longest time. The BSM proved to be too slow and inefficient in filtering out the gas. Large gas pockets would build up & the glue would fail after multiple trials.

Future Changes:

- Try a different membrane material or pore size that would not let the vapor coolant pass through and would be more durable
- Use larger membrane surface areas or more bleed points to release the gas at a faster rate.

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