Structured Adsorbent Media for Maintaining Cabin Air Quality

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Abstract

Figure 1. Microlith module in test stand

Current methods for Trace Contaminant (TC) control on the International Space Station use packed lithium hydroxide (LiOH) beds for removal of acid gas. Though effective, the LiOH beds have exhibited efficiency problems. Post-flight analysis shows reaction of only 8 cm of bed depth along with size reduction of LiOH granules. The LiOH dust increases flow resistance, dropping pressure and eventually causing the system to shut down. Therefore, the system is replaced every 4.5 years. In response to these issues, the structure and reaction of the LiOH bed is studied. In addition, a Microlith® sorbent module has been produced consisting of metal mesh filters coated with zeolite materials and structured in a "jelly-roll" fashion. The structured media studied demonstrates increased thermal efficiency and durability and a significant decrease in fine dust.

LiOH Sorbent Bed Assembly

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Chemical reactions of LiOH and Li_2CO_3:

$$2LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$$
$$Li_2CO_3 + 2HCl \rightarrow 2LiCl + H_2O + CO_2$$
$$Li_2CO_3 + 2HF \rightarrow 2LiF + H_2O + CO_2$$

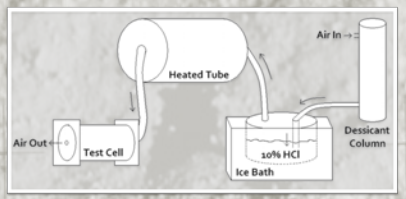

Figure 2. Test cell with mesh-filter-mesh (left); Schematic for running tests (right)

Microlith Trace Contaminant Adsorber

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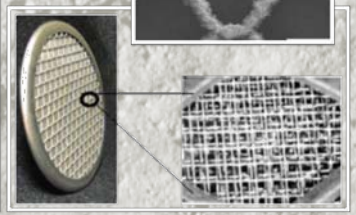
Figure 3. "Jelly-roll" configuration (left); Zeolite on Microlith (top right); Microlith mesh (bottom right)



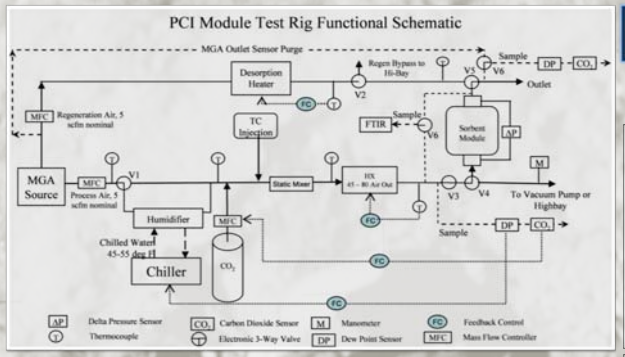
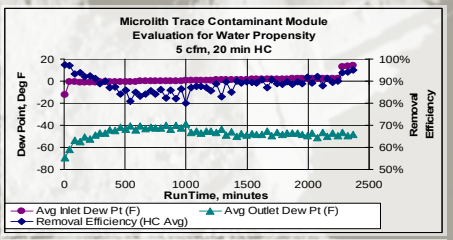


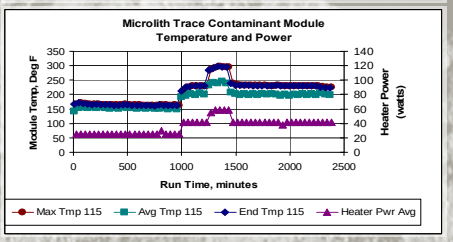
Figure 4. Microlith test stand schematic (top); Actual test stand (left)

Contaminant Injection Rates from Liquid Phase

Formula: $\frac{1\ mL}{Y\ g} \times \frac{Z\ mg}{1\ m^3} \times \frac{1\ g}{1000\ mg} \times \frac{5\ cu.\ ft.}{1\ min} \times \frac{0.028\ m^3}{1\ cu.\ ft.} \times \frac{10^3\ \mu L}{1\ mL}$

Solvent	Formula	Y = Liq. Density (g/mL)	Z = Conc. (mg/m³)	Injection Rate (µL/min)
Ethanol	C_2H_5OH	0.789	161.8	29.03
Acetaldehyde	CH_3CHO	0.78	10.3	1.87
Xylene	$C_6H_4(CH_3)_2$	0.87	10	1.63
Dichloromethane	CH_2Cl_2	1.32	10.1	1.08
Acetone	$(CH_3)_2CO$	0.788	9.7	1.74





Microlith Adsorber Flow Rate

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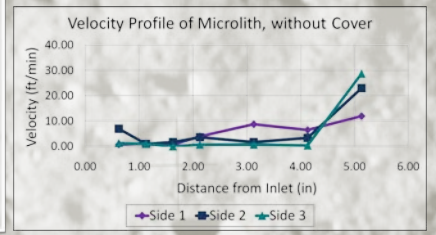

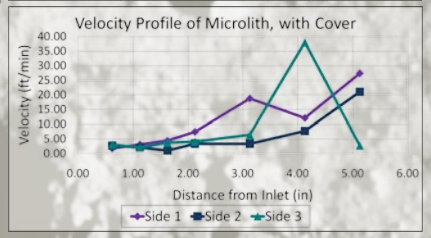

Figure 5. Velocity testing of Microlith without cover

Conclusions and Future Work

- LiOH apparatus is still being assembled. Research is expected to provide insight on flow resistance within the LiOH test cell as well as reaction between the metal shell and acid gas.
- Previous tests of TC adsorber show the module removes minimal amounts of CO_2 while current tests show the module can potentially serve as a back-up H_2O adsorber. Full analysis of TC adsorption yet to be completed. In the future, the RD, TC, and CO_2 modules be combined and scaled to the necessary size.
- Flow rate testing demonstrated inconsistent pressure throughout the module. Future work involves modifying the air flow by narrowing the passage with an insert (***left***).

References

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Acknowledgements

Special thanks to Dr. Frank Six, Dr. Gerald Karr, and the NASA Academy for the opportunity to conduct research and to the DC Space Grant Consortium for funding. Much gratitude is also extended to the friendly people working on ECLSS for all the help and support.