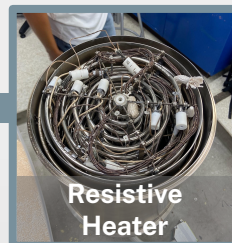




Improving Multifunctional Sorbent Technology for Carbon Dioxide Adsorption

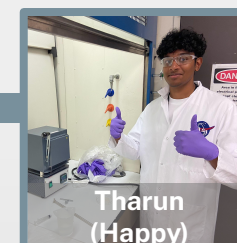
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Abstract:

The MultiSORB system aims to improve life support on the ISS and other craft such as the Orion capsule via new technologies that enable more efficient CO₂ adsorption. This means that life support systems can function with less power and greater reliability while still processing nominal quantities of CO₂. The technologies explored in this poster include the use of zeolite paste in the creation of novel geometries, along with the use of state of the art heating/cooling systems such as titanium heat pipes.



Paste Formulation

Background:

Traditional 4BCO₂ systems employ zeolite CO₂ removal with the use of pellets. However this geometry leads to poor thermal stability within the 4BCO₂ along with dusting. Working with zeolite in paste form offers much more flexibility when it comes to both the construction and composition of the paste.

During my internship I experimented with the quantity of water in the paste mixture.



Experiment Setup:

Three samples of paste were mixed, each one containing different quantities of water. The amount of water is represented by the mass of the zeolite powder it is equal to.

- 3 Samples were created, 100% (Half water, half powder) 130%, and 200% (1 part powder, 2 parts water)
- Powder was massed out, then mixed with water creating a exothermic reaction
- Samples were allowed time to dry
- Each sample was placed in an oven at 350°C for 9 days



Challenges:

I originally intended to make samples of 70%, 100%, and 130% concentrations. However after making the 100% mixture, I realized that any less water would result in a mixture that did not mix well and was too viscous to work with. I instead opted for a 200% mixture in the 3rd sample.

Conclusions/ Results:

A higher water content resulted in a less viscous paste that dried with a smoother finish and less surface defects. Other tests have revealed that the mixtures with a lower water content are stronger, while being worse at absorbing CO₂. 100 and 200% mixes represent the extremes in concentration, while 130% water is ideal for making paste.

References:

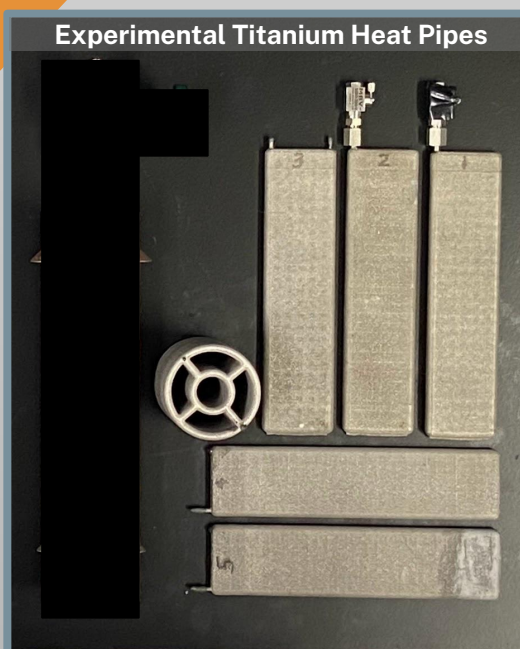
- 1) Richardson, T. M. J., Peterson, K., Boghozian, T., Alpert, H., Visser, S., Klar, G., ... & Dzurny, Q. (2023, July). Multifunctional Sorbent (Multisorb) Devices For Carbon Dioxide Removal. 2023 International Conference On Environmental Systems.
- 2) Alpert, H. S., Peterson, K., Richardson, T. M. J., Dzurny, Q., & Peterson, G. P. (2023, July). Thermal Modeling Of A Novel Air-Cooled Temperature Swing Adsorption Compressor (Ac-Tsac). In 52nd International Conference On Environmental Systems (Ices 2023).

Heating Systems

Background:

Zeolite pellets/ paste must be heated to release the CO₂ they adsorb from the air. This allows them to be reused in a continuous cycle of adsorption and desorption. Zeolite is naturally an insulator, meaning that an efficient design is critical to limiting the amount of power required to heat up a sorbent bed to a nominal 200°C.

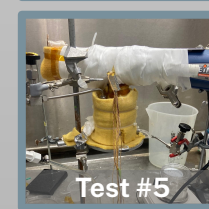
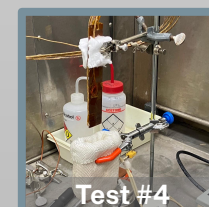
During my internship I worked with Jorge Pombo to measure the thermal conductivity of experimental heat pipes.



Experiment Setup:

Testing the heatpipes accurately proved challenging, and multiple setups were constructed in an attempt to gather accurate measurements. However they were all based around the same design principles.

- One side of the test article would be heated while the other would be cooled
- Thermocouples would be mounted across the heat pipe, and in some cases on the heating/ cooling elements
- All exposed areas were covered in insulators such as fiberglass and Kapton tape.



Challenges:

Heat loss was an incredibly difficult challenge to overcome, with losses in heat being difficult to detect and difficult to combat. In addition to this, the thermocouples we used were prone to drifting or failing, which introduced yet another unknown variable for us to tackle.

Conclusions/ Results:

At present, our results on test articles continue to be off by at least a factor of two. This is much better than the data we started with, but not good enough to draw conclusions from. In the future, conducting our tests in a vacuum chamber could limit thermal loss, as heat cannot travel via conduction in a vacuum.

Acknowledgements:

I would like to thank Tra-My Justine Richardson for her dedication as my mentor. Throughout my internship she consistently and persistently supported me.

I would also like to thank Tyler Novet, for helping me apply to and get this internship. It has been a transformative experience that would not have happened without his help.

Finally I would like to thank Jorge Pombo, who helped me with the experimental heat pipes and who without I would not have got nearly as far as I did.

Acronyms:

4BCO₂ - Four Bed Carbon Dioxide

NASA - National Aeronautics and Space Administration

CO₂ - Carbon Dioxide

MultiSORB - Multifunctional Sorbent

ARC - Ames Research Center

ISS - International Space Station