STUDY OF THE ADSORPTION OF CO_2 BY CARBON FILTERS

Romeoville High School

Olivia DePaola[1], Nico Moran[1], Anna Noga[1], Samantha Padal[1], Ghada Ali[1], Sandrine Clairardin[1], and Dr. Luca Rebuffi[2]

[1]Romeoville High School, IL. 60446

[2]Argonne National Laboratory, IL 60439

ABSTRACT

CO_2 resulting from coal burning causes severe health risks due to the environmental contamination, including, but not limited to, cardiovascular and respiratory diseases [1]. A coal burning facility produces different gaseous pollutants like N_2O and SO_2, but we have determined carbon dioxide as the most detrimental to the perspicuity of individuals lungs and respiratory systems. In other studies, coal fly ash contains unburnt organic materials such as carbon nanotubes, that may be recovered and used in many industries[2]. The filtration device is composed of two chambers with a CO_2 sensor in each. When using our filtration device, we noticed a common pattern of the concentration of CO_2 in the polluted and the purified chambers for both types of filters. The filters were observed using a scanning electron microscope, and beamline 2-BM-XSD micro tomography.

MOTIVATION

- Our school is located in close proximity to a coal-burning power plant.
- CO_2 resulting from coal burning causes severe health risks to cardiovascular and respiratory diseases.
- We have determined carbon dioxide as the most detrimental to the perspicuity of individuals lungs and respiratory systems

METHODS

Filters: Carbon-water mixture was homogenized, filtered, and placed on gauze membrane (Figure 1). The gauze filters were placed in a water bath to desorb them from CO_2. The filters then were placed in our device to run trials using a 3D printed frame (Figure 2).

The Filtration Device: The filtration device is composed of two chambers connected with a gas blast (Figure 3). A CO_2 sensor was placed in each chamber. The chambers were secured and each was tested for leakage. The carbon filter was placed in the clean chamber. CO_2 was introduced to the polluted chamber using a CO_2 cartridge, and the concentration was collected.

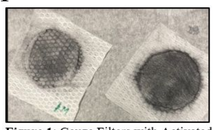

Figure 1: Gauze Filters with Activated Carbon Powder

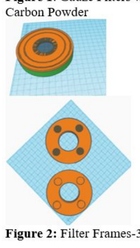

Figure 2: Filter Frames-3D Designs

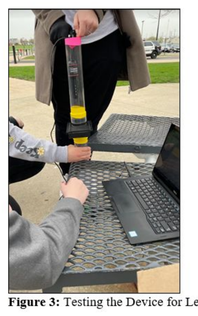

Figure 3: Testing the Device for Leakage

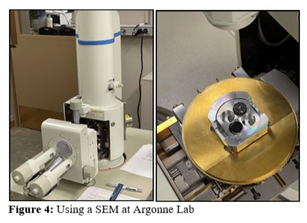

Figure 4: Using a SEM at Argonne Lab

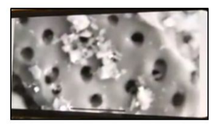

Figure 5: The Porosity of Activated Carbon-Coconut Shell Derived as shown Using a SEM

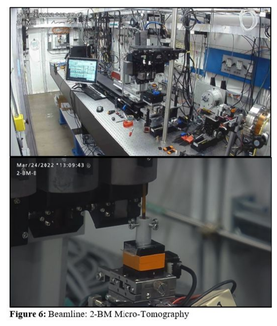

Figure 6: Beamline: 2-BM Micro-Tomography

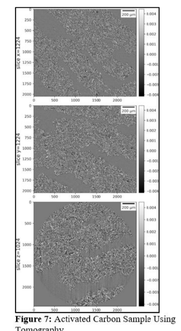

Figure 7: Activated Carbon Sample Using Tomography

DATA & RESULTS

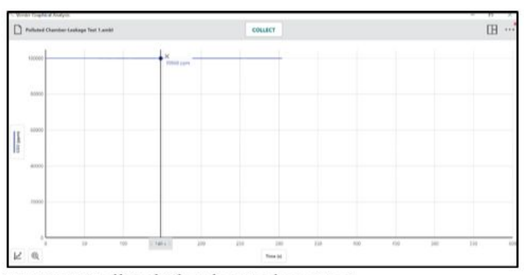

Figure 8: Polluted Chamber Leakage Test

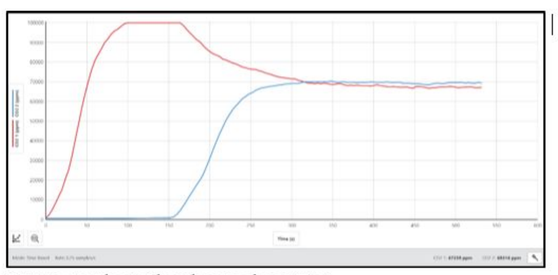

Figure 9: Clean Chamber Leakage Test

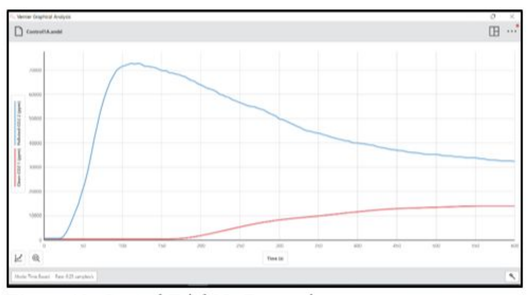

Figure 10: Control Trial-No Desorption

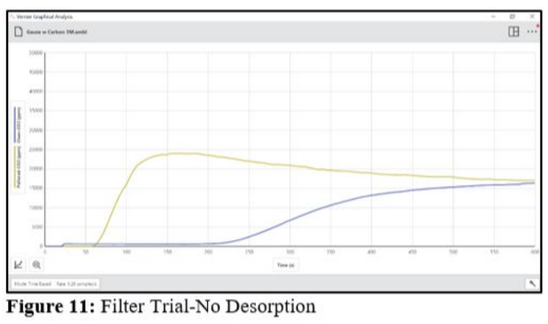

Figure 11: Filter Trial-No Desorption

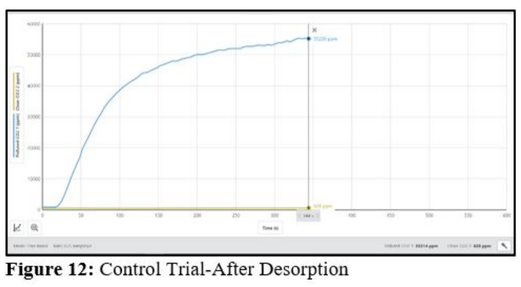

Figure 12: Control Trial-After Desorption

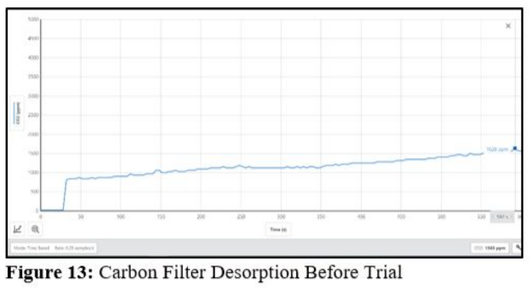

Figure 13: Carbon Filter Desorption Before Trial

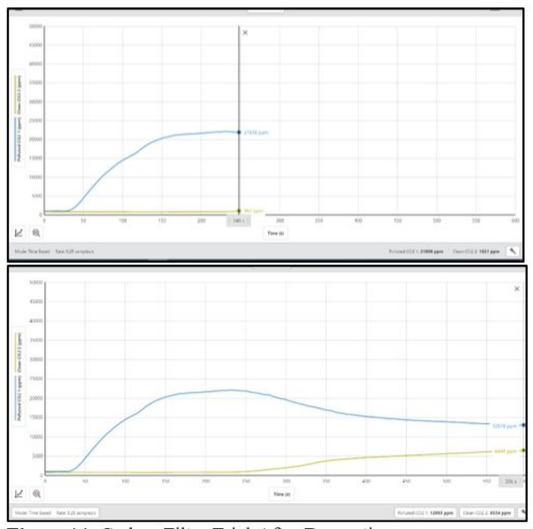

Figure 14: Carbon Filter Trial-After Desorption

- The samples tested at the lab (Figure 4 & 5) needed to be revised to ensure porosity. Gauze was used as a membrane instead of a binding substance (figure 2 & 3).
- The chambers' tests resulted in an insignificant leakage of less than <1% (Figure 8 & 9)
- Activated carbon filters tests demonstrated a significant amount of adsorbed CO_2. Filters needed to be desorbed before running further trials (Figure 10 & 11)
- Desorbed carbon filters worked at a higher efficiency compared to our control (Figures 12 -14). While the control blocked 14.9% of CO_2 introduced to the polluted chamber, the carbon filter blocked 31.3% of the CO_2 introduced within the first 20 minutes of running the experiment (Figure 15).

	Initial Difference in CO_2 Concentration (ppm)	Final Difference in CO_2 Concentration (ppm)	Percentage of CO_2 Filtered
Control Sample (Desorbed Gauze)	55,230 – 344 = 54,886	23,131- 14,935 = 8,196	14.9%
Test Sample (Desorbed Activated Carbon Filter)	21,838 – 962 = 20,876	12,979 – 6,444 = 6,535	31.3%

Figure 15: Data Table. Percentage of CO_2 filtered at the end of 20 minutes of data collection.

CONCLUSIONS

- The filtration device presented an insignificant amount of leakage (<1%) of CO_2.
- The filters needed to be desorbed before running trials.
- Desorbed carbon filters were able to adsorb CO_2 at a significantly higher percentage than the control.

NEXT STEPS

- Manufacturing a practical filter to be able to test its efficiency over a longer duration of time is needed.
- Activated carbon filters ability to adsorb CO_2 will be compared to carbon nanotube filters.

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