STUDY OF THE ADSORPTION OF CO\(_2\) BY CARBON FILTERS

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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\(_2\)O 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.

DATA & RESULTS

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 experiments’ results 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).

The control blocked 14.9% of CO\(_2\), but we have determined carbon dioxide as the most detrimental to the perspicuity of individuals lungs and respiratory systems.

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.

REFERENCES

\[6\] Wagener, Laura. Climeworks: Where Carbon Capture Meets Greenhouse Fertiliser. RESET.

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