Direct Air Capturer

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Materials and Methods

Materials

We received several of our materials on 12/07/21, which included the air pump, sodium hydroxide, suction fan, plastic sheets, and the four-inch pipe. On 12/09/21 we received the exhaust fan, five-inch pipe, plastic containers, and carbon meter. We began by creating the plastic filter, which was cut to 20.35 cm by 6 cm but found that it was too small to properly divide the container. We then cut another piece to a size of 20.7 cm by 10.4 cm which fit more snugly than the previous cut. Hot glue will be used to fill in any gaps that occur as a result of the container shape.

Figure 1: The image above is the carbon meter along with its CD and other components on the day it was received.

After receiving all of our materials, we placed them on the container lid as shown below to reflect how the device would be set up once we began the construction process.

Figure 2: The image above is our tentative setup for the carbon capture device.

Methods

Over the last few weeks, our group decided to reach out to GSIP's chemistry teacher, Dr. Alexis Patanaraut, to inquire about the use of sodium hydroxide in our project. Our main questions revolved around the feasibility and legitimacy of this chemical.

We formatted an email, asking the questions above in detail:

Hello Dr. P,

We hope you are doing well! I am in a physics mentorship group with two other students, and we are working to build a system that will reduce carbon dioxide concentrations in

the air. We wanted to ask a few questions concerning some chemistry related aspects of our project.

Our system will involve intaking ambient air with a suction fan. Then, the air will be stored in a container with water. We will then add a certain amount of sodium hydroxide to the water to chemically alter it. This new, chemically altered air will be released back in to the atmosphere. This is the balanced equation we are using for our reference:

2NaOH + CO(2) = Na(2)CO(3) + H(2)O

We had a few questions:

- Is this a legitimate chemical equation that we can work with? Will the chemical alteration effectively reduce carbon dioxide emissions?
- Will the sodium hydroxide cause a change in the water levels or in the consistency of the solution? Would we have to check pH levels to ensure that the system works effectively?
- What are the proportions for creating this solution? In other words, how do we turn this balanced equation into real life measurements?

Thank you so much for taking the time to read this and answer these questions! We really appreciate it.

She responded back to our email with some feedback on our research design:

> While the equation that you mentioned in your email is a legitimate one, there are some things that you would need to take into consideration for this experiment. For one, there is the matter of how you will account for potential evaporation of the solvent over time, so continual monitoring of liquid levels and possibly pH to make sure that there are no drastic changes to the solution over long term use.
>
> Also in general, unless we are talking about exhaust from pipes of industrial plants and such, the usual concentrations of CO2 in the air are quite low to begin with. CO2 sequestration technologies often involve fixtures placed near or around such pipes to remove the chemical exhaust, but if you're trying to measure CO2 in regular air, those concentrations are most likely pretty small to begin with
>
> Then there is the reaction of CO2 when it comes to contact with water too that should also be taken into account. It sounds like though you are looking to purify the air of CO2. Have you looked into CO2 sequestration technologies? I believe some have tried using your approach with NaOH, but utilized more of an aerosolized format to directly remove CO2 from the air. There is also activated charcoal filters too that have been pursued as another way of cleaning the air of CO2 levels as well.

As a group, we then addressed some inquiries and discussed how to move forward with our project. We were not sure about the threshold for the appropriate pH levels of the solution

that will ensure a proper experiment. Additionally, we were not sure about the reaction of this H2O and NaOH solution with ambient air, so we wanted to address that in our next response:

Hello Dr. P!

We just wanted to confirm that you received our email from a few weeks ago. Thank you so much for providing your insight and feedback. We responded to your feedback in bold ☺.

While the equation that you mentioned in your email is a legitimate one, there are some things that you would need to take into consideration for this experiment. For one, there is the matter of how you will account for potential evaporation of the solvent over time, so continual monitoring of liquid levels and possibly pH to make sure that there are no drastic changes to the solution over long term use.

Thank you for letting us know! In our preliminary testing, we will take into account the evaporation of the solution. How do we know, though, the threshold for the liquid/pH levels of the solution?

Also in general, unless we are talking about exhaust from pipes of industrial plants and such, the usual concentrations of CO2 in the air are quite low to begin with. CO2 sequestration technologies often involve fixtures placed near or around such pipes to

remove the chemical exhaust, but if you're trying to measure CO2 in regular air, those concentrations are most likely pretty small to begin with.

We are using ambient air to first test our hypothesis that temperature levels change with the CO2 levels in our modeled environment! We hope to further this by physically taking the system to area with a higher carbon exhaust.

Then there is the reaction of CO2 when it comes to contact with water too that should also be taken into account. It sounds like though you are looking to purify the air of CO2. Have you looked into CO2 sequestration technologies? I believe some have tried using your approach with NaOH, but utilized more of an aerosolized format to directly remove CO2 from the air. There is also activated charcoal filters too that have been pursued as another way of cleaning the air of CO2 levels as well.

We do want the CO2 to react with the aqueous solution of sodium hydroxide and then be altered to sodium carbonate and water. What kind of reaction will happen if ambient air goes into the solution? We are just planning to use the air around us to do this entire reaction, as of right now, and after researching multiple capturing methods, we found this to be the most feasible for our hypothesis and environmental setup.

Sincerely,

Jennine Faruque, Nawah Ahmad, Sejal Sharma

Dr. P has not yet responded to our latest response.

Our next step was testing the CO2 meter to ensure that it works in different settings. We performed a quick test by placing the CO2 meter in different settings, and noticed that the value (in particles per million) differed accordingly. The CO2 levels increased when it was near high levels of breathing. After this, we figured out the various mechanisms of the CO2 meter.

On Saturday, January 15th, our plan is to reconvene at Nawah's house to complete building the apparatus. We plan to drill holes on the container as much as possible. If time permits, we will begin to perform preliminary testing. If not, we will at least plan our initial testing procedures.

Our next step is preparing for the proposal paper and presentation. We plan to use our experimental design diagram as a basis for our proposal, as well as include updates on our new methods. Our existing article summaries will help with drafting the literature review.

Data Analysis

In our first trial with testing the software that came with the AZ 7755 Carbon Meter, we faced some dilemmas with running the software. Upon trying to download the needed application and manual files from our file explorer, the error of "not responding" popped up, and the pages then refused to respond (Figure 3).

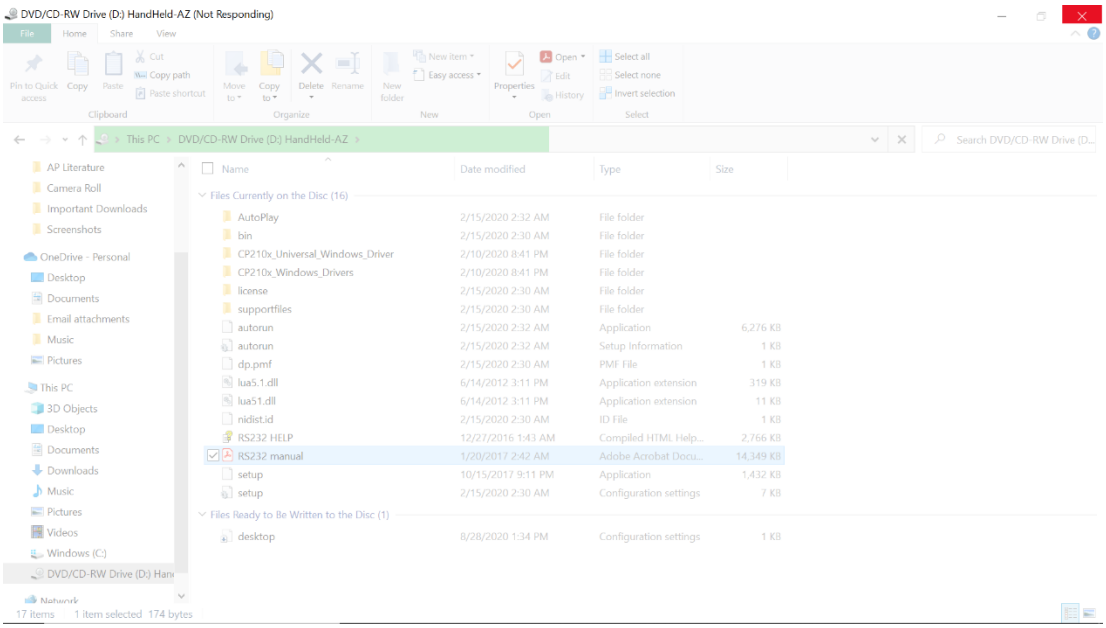

Figure 3: The image above is the screenshot captured when the program was not responding during the first attempt to run the software.

We then attempted this a second time after break, and the CD was able to load the files stored on the disc. However, when clicking on the actual files themselves, the screen froze again (Figure 4). After restarting the setup of the disc reader and the CD, the auto-run file was able to load the download pop-up. We were able to install the software, and we plan to test this further with the collection tool options available with the CO2 meter. We start the preliminary testing, with the collection increments and data analysis methods available in the software, we will analyze the data graphically over time (Figure).

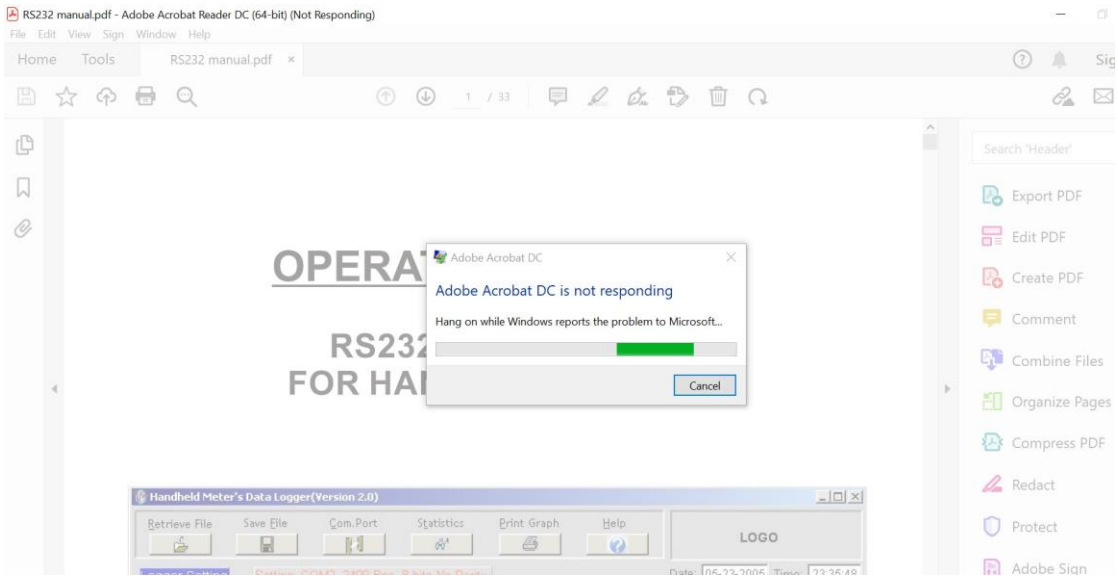

Figure 4: The image above is the screenshot captured when the program was not responding during the second attempt to run the software.

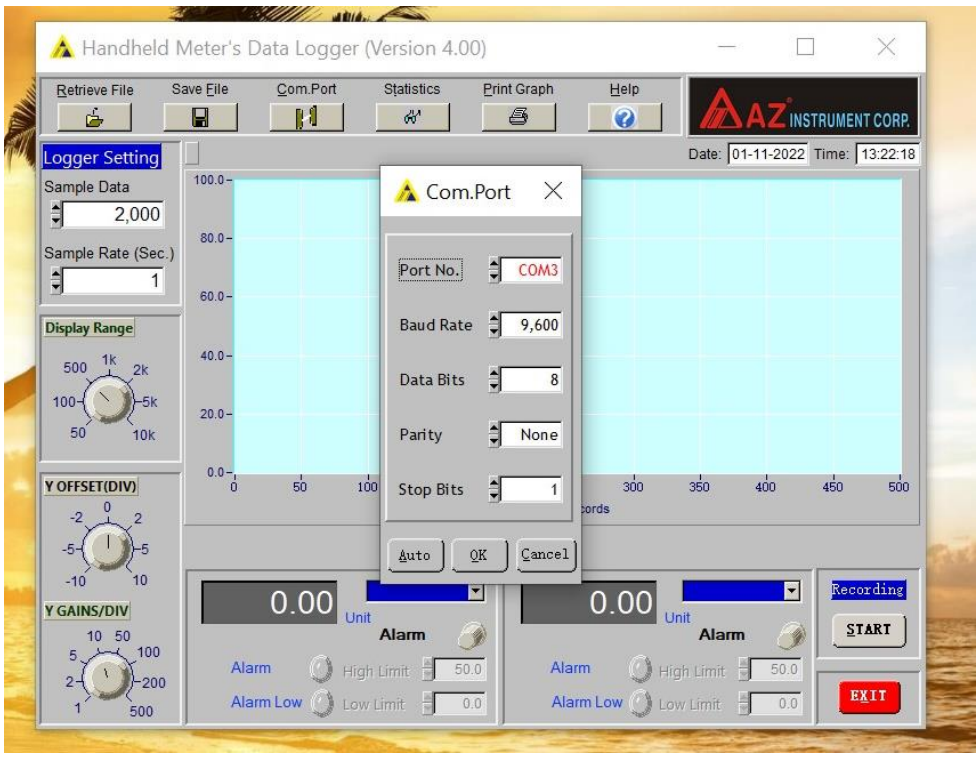

Figure 5: The image above is the screenshot captured with the sample outputs given by the software. Using this, we plan to collect and organize any information attained in the trials of our experimentation.

References

Dm, K. [Karthik Dm]. (2019, February 12). *Carbon Capture Machine | Carbon dioxide Absorber | Reduce CO2 level in Atmosphere* [Video]. Youtube. https://youtu.be/MO3xM9jpwHs