CO2 Filtration Device for Automobile Exhausts

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Engineering Need

There is currently little **consumer-level technology** that directly captures or removes CO_2 at the **point of emission** in cars.

Engineering Objective

Design and prototype a chemical-scrubbing exhaust attachment that uses **Hydroxide-based filtration** to remove CO_2 from **car exhaust streams**

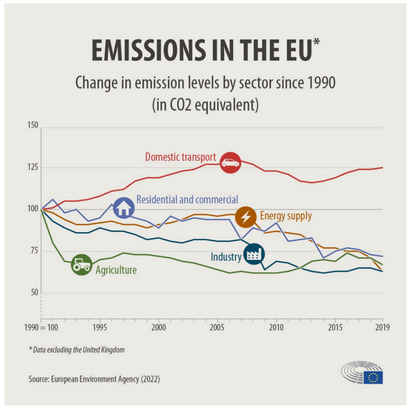


Figure 1: Compares changes in emission levels of different sectors in the EU since 1990. (Parliament, 2019)

- Driving **Climate Change**
- **Transportation** is a large portion of CO2 emissions
- **33.5%** increase in emissions between 1990 and 2019 (Parliament, 2019)

- **Hydroxides -** Chemicals containing hydroxide ion (OH)
- **Chemical Scrubbing** - Filters by creating new byproducts within a chemical reaction
- **Impinger** - Device that allows airflow, and contains a filtration method

Methodology

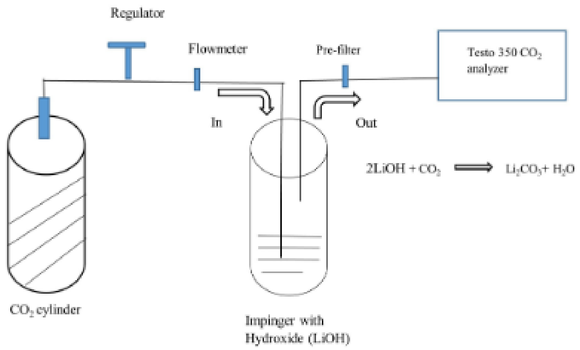


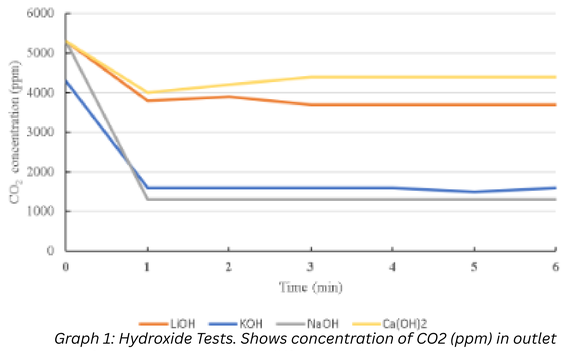
Figure 2: Hydroxide testing procedure. Using CO2 gas, impingers and a gas analyzer. Chemical scrubbing produces Carbonate & Water. Example showcases process with Lithium Hydroxide(LiOH)

- **Hydroxide testing** - Cylinder filled with Nitrogen-gas mixture flows into impinger containing hydroxide. Filtered gas flows into gas analyzer (Graph 1)

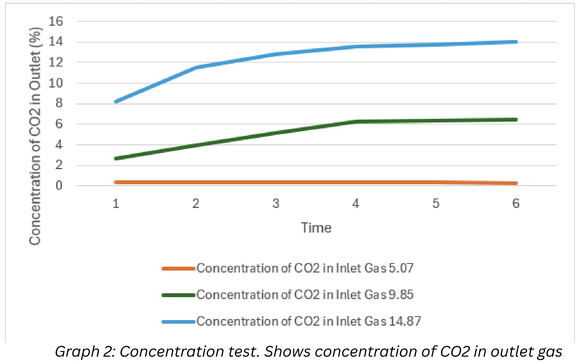
- Using the same method, I then varied the **CO2 concentration** of the gas and tested filtration of **1 hydroxide** (Graph 2)

- Finally I varied CO2 concentration again, but with **two impingers** (Table 3)

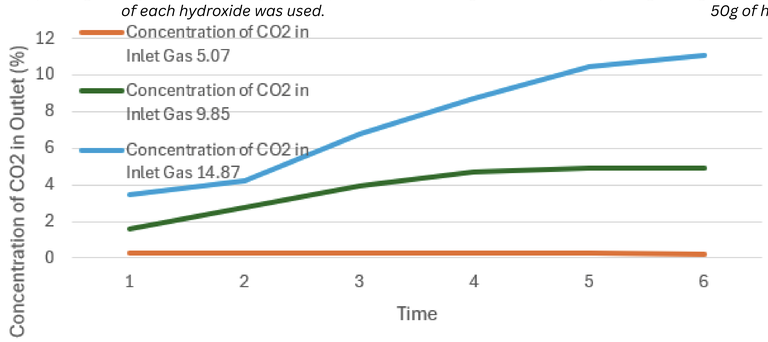
Results/Figures



Graph 1: Hydroxide Tests. Shows concentration of CO2 (ppm) in outlet gas after passing through the different hydroxides, over 6 minutes. 25g of each hydroxide was used.



Graph 2: Concentration test. Shows concentration of CO2 in outlet gas after passing through NaOH, with varying initial CO2 concentrations. 50g of hydroxide was used.



Graph 3: Concentration test with Dual impingers. Concentration of CO2 in outlet gas after passing through 2 layers of NaOH, with varying initial CO2 concentrations. Uses 50g per impinger.

Analysis

Test 1:

- **LiOH** ~ 32.40%,
- **KOH** ~ 68.60%
- **NaOH** ~ 74.5%
- **Ca(OH)2** ~ 24.9%

- NaOH was **most efficient** at filtering CO2 at a low level

Test 2:

- @5% ~ 93.2%
- @10% ~63.6%
- @15% ~ 25.1%

- NaOH is **inefficient** at high concentrations

Test 3:

- @5% ~ 95.6%
- @10% ~78.0%
- @15% ~ 51.2%

- **Multi layered** filtration greatly increases efficiency

Future Steps

- **Improve filtration** capability with more layers/more hydroxide
- **Construct and test** physical filter device in **real-world** applications

Key Takeaways

- **NaOH** filtered CO2 most efficiently
- **Multi-layered** hydroxide filtration improved filtration
- **Real world** building & testing is needed