

CO2 EMISSION REDUCTION THROUGH BARTHX FILTER

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I. Project Overview

1. Project Context

As part of our academic curriculum, EMINES School introduces us to entrepreneurship and critical thinking, aiming to develop ideas with strong implementation potential.

2. Objective

The goal is not merely to pursue random ideas but to create solutions with added value that can impact local communities or broader circles.

II. Problem Statement

1. Diesel and Petrol

- Diesel: A complex mixture of aliphatic hydrocarbons (C_nH_{2n+2} , C_nH_{2n} , C_nH_{2n-2}), including cyclic and paraffinic compounds with 13–18 carbon atoms.
 - Significant sulfur content (decreasing in Europe under EN 590 standards).
 - Potential sulfur dioxide (SO_2) emissions in unregulated regions.
 - Emissions of CO_2 , nitrogen oxides (NO_x), and fine particulate matter (PM).
- Petrol: A blend of light hydrocarbons, primarily heptane (C_7H_{16}), often with additives. Pollutant emissions post-combustion are similar to diesel.

2. The Problem

Diesel, petrol, and transportation collectively constitute a major driver of climate change and air pollution. Despite regulations like EN 590, vehicle CO_2 emissions remain a critical pollution source, accounting for 34% of global CO_2 emissions in 2023 (per the French Ministry of Ecological Transition). Thus :

How can we effectively reduce CO_2 emissions from diesel and gasoline vehicles, aggravated by current filtration systems focused on toxic gases (NO_x , CO), by developing an innovative solution without compromising engine performance?

III. Design of a System Incorporating ZIFs (Zeolitic Imidazolate Frameworks) into a Filtering Substrate to Enhance CO_2 Absorption

a. Potential Reactions with Constituents Emitted by Petrol/Diesel Combustion

The solution combines Metal-Organic Frameworks (MOFs) and a filtering substrate, leveraging their properties.

Current vehicle filtration systems (e.g., particulate filters) reduce NO_x , CO, and unburned hydrocarbons (HC) into water (H_2O) and CO_2 . However, these systems prioritize reducing highly toxic gases in small quantities, leading to increased CO_2 emissions over time.

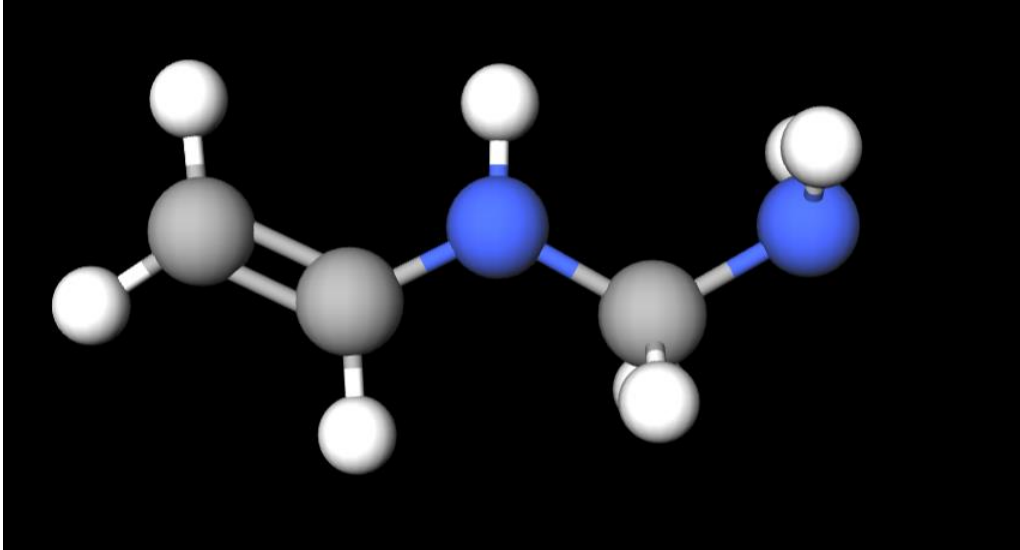
Components of ZIFs

- Imidazole ($C_3H_4N_2$)
- DMF (N, N-Dimethylformamide, C_3H_7NO): A universal organic solvent with high dissolution power and dipole interactions for CO_2 capture in MOFs.
- Metal cations (e.g., Zn^{2+})

Potential Reactions with Combustion Byproducts

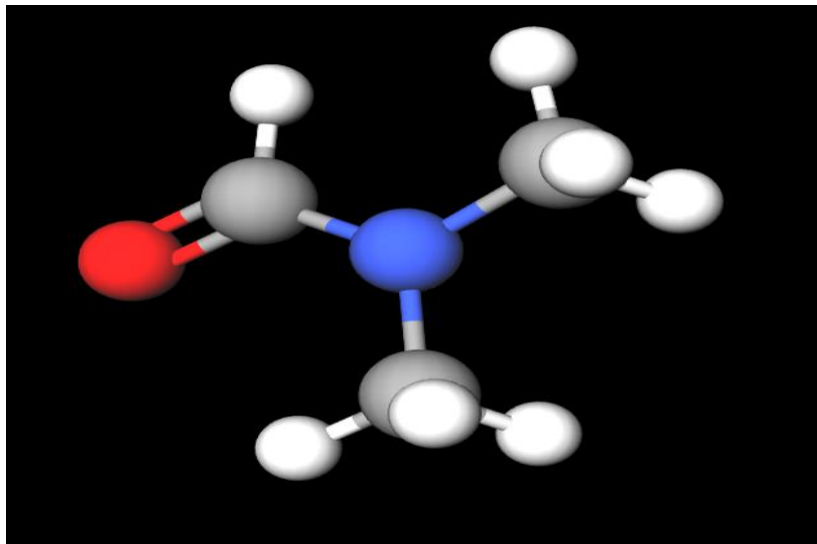
Scenario: Engine leaks causing exposure of materials to combustion byproducts.

- SO₂ Emission Case :
 - $\text{C}_3\text{H}_4\text{N}_2 + \text{SO}_2 \rightarrow ?$ (Assessing imidazole's impact on SO₂)



Structure chimique de l'imidazole

- $\text{C}_3\text{H}_7\text{NO} + \text{SO}_2 \rightarrow ?$ (Assessing DMF-SO₂ interactions)



Structure chimique du DMF

- $\text{Zn}^{2+} + \text{SO}_2 \rightarrow \text{ZnSO}_3$ (Zinc sulfite formation, aiding SO₂ capture/conversion).
- Required Materials :
 - DMF
 - Zn⁺ metal ion solution
 - Coating substrate (ceramic, e.g., cordierite or silicon carbide (SiC))

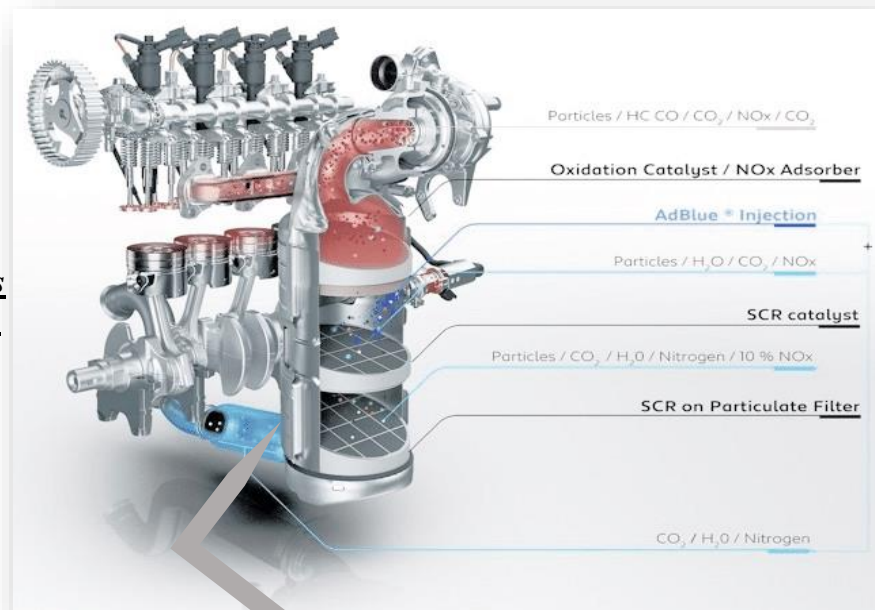
Key Questions

- How will captured CO₂ be recovered and stored post-implementation?

b. Prototype and Insertion Zone

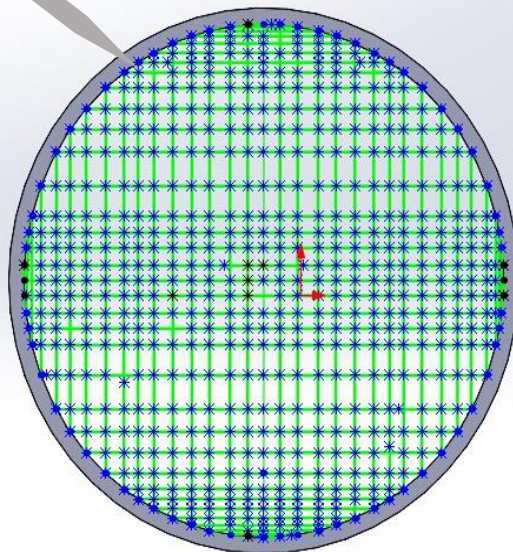
The implementation will take place right after the initial particulate filter, where particles resulting from the combustion of either diesel or gasoline are released. Below is the particle transfer mechanism and the prototype of the proposed solution.

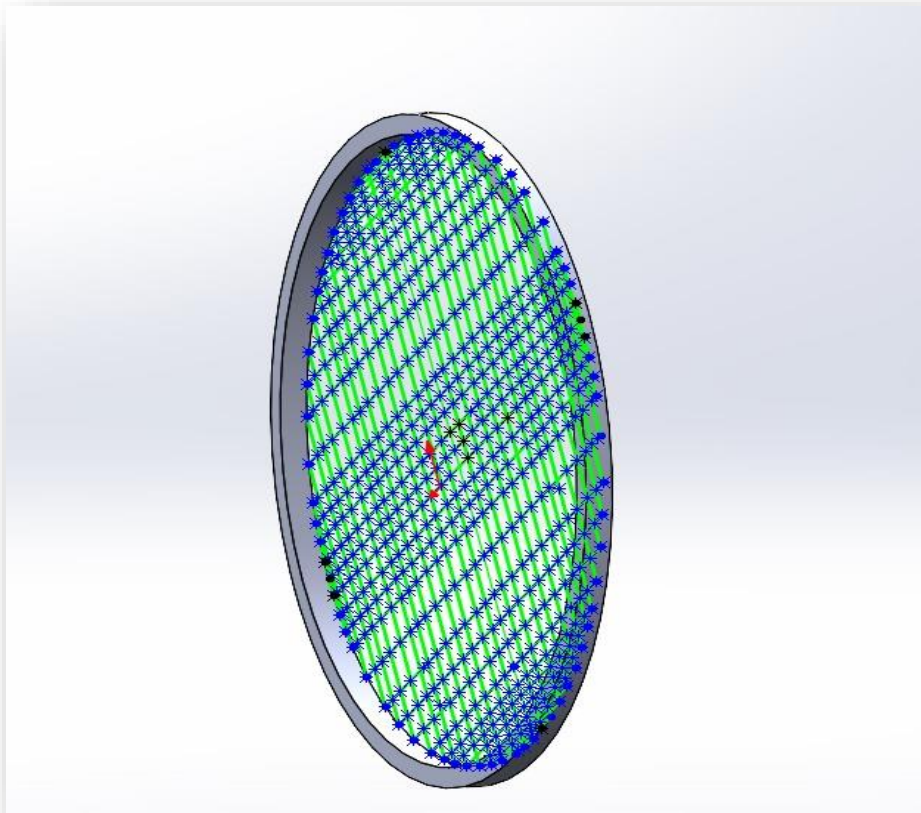
Particle Filtration Process in Engines (Petrol/Diesel)



Substrate insertion zone: Final filtration of the particles emitted by the particulate filter.

SOLIDWORKS PROTOTYPE





Sources :

- cnesst.gouv.qc.ca
- demotor.net
- statistiques.developpement-durable.gouv.fr