Sustainable Conversion of CO2 in Cement Production

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AFFILIATIONS

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With the rapid increase of mega projects in Saudi Arabia, cement producers face a problem with an increase in harmful emissions. So, for cement producers who require more sustainable practices, our Mineralization Process is a carbon treatment method that will securely store and integrate at least 10% of emitted carbon into the cement cycle. Unlike geological storage, the Mineralization Process offers secure storage by mineralizing carbon and integrating it into the cement production

CO2 Absorber

01. Introduction

Our project tackles the pressing challenge of reducing CO2 emissions in Saudi Arabia's cement industry. By proposing an innovative on-site conversion process, we aim to transform emitted CO2 into carbonate minerals. Through interdisciplinary collaboration and strategic problem-solving, we're driving towards a more sustainable and economically viable solution.

02. Objective

Develop an economically viable on-site CO2 conversion process, integrating absorption, and mineralization techniques to reduce emissions and enhance sustainability in cement production

03. Problem statement

Cement industries emit 70 million tons of CO2 in Saudi Arabia yearly. Conventional mitigation risks exist. Our challenge is to develop an economically viable on-site CO2 conversion system that will convert CO2 to carbonates to securely store it.

Related literature

https://www.spa.gov.sa/2392092

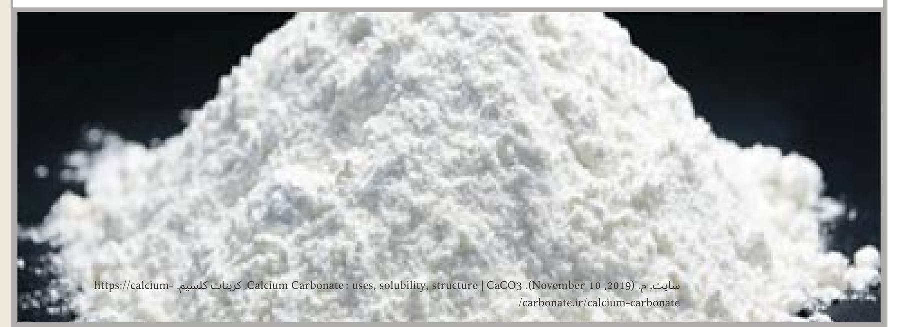
Chemical Reactions

$$CO_{2(g)} + H_2O \rightleftharpoons H_2CO_3$$

$$H_2CO_3 + OH^- \rightleftharpoons HCO_3^- + H_2O$$

$$HCO_3^- + OH^- \rightleftharpoons CO_3^{2-} + H_2O$$

$$\boldsymbol{Ca^{2+} + CO_3^{2-} \rightleftharpoons CaCO_{3(s)}}$$



04. Project Impact

- **Reduced CO2 emissions**
- **Enhanced sustainability**
- **Raising awareness**
- **Decreasing Environmental Pollution**

pH Controller

05. Results/Findings

One significant findings from prototype testing is that retaining precipitation within the reactor and conducting multiple runs leads to an increase in conversion rates.

- **pH 8.0** +25%
- **pH 8.5** +9%
- **pH 9.0** +8%
- **pH 9.5** +7%

Other Findings

- **Ideal pH levels enhance carbonate formation**
- **Consistent operations improves conversion**
- **Baffles and packing materials enhance absorption**

CONSTRAINTS

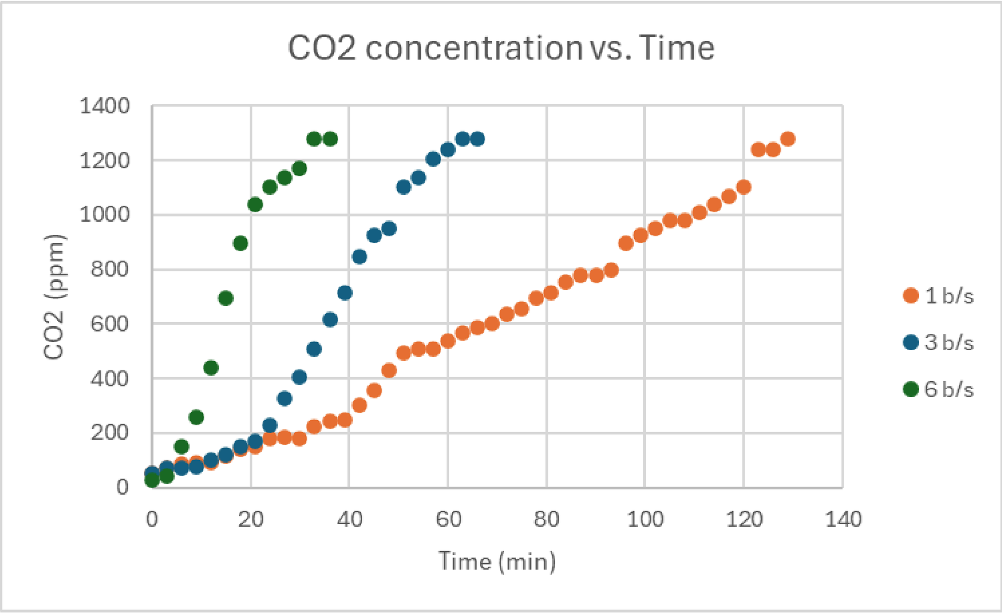
- *Constant Monitoring of the pH levels.*
- *Determining the CO2 concentration in the prototype.*
- *Well mixing of the reaction.*
- *Regulating the temperature for maximum dissolution of CO2*

SPECIFICATIONS

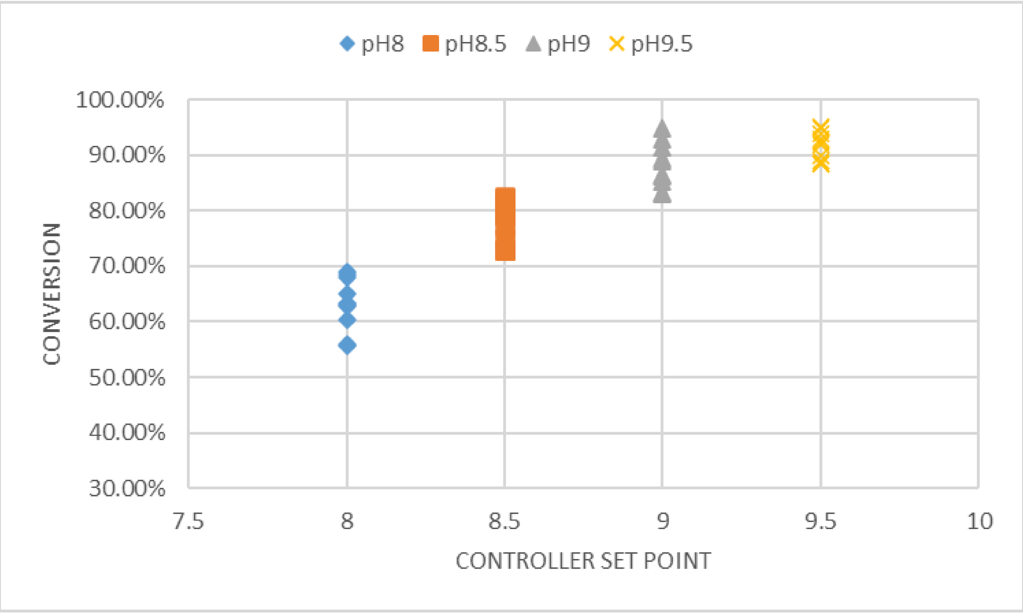
- *Material that withstand a pH from 3 up to 11*
- *90% conversion of calcium ions to calcium carbonate*
- *a stable pH range between 9 and 9.5*
- *Minimum 800 ppm CO2 absorption in water.*

06. Analysis

The prototype underwent comprehensive analysis, including measuring saturation time of the absorber using the pH, kH test. Assessing CO2 conversion to calcium carbonate based on various pH set points. Data analysis involved examining trends, correlations, and optimizing operational parameters for enhanced performance and efficiency.



Saturation time variation with different inlet flow rates



Measuring reactor performance against pH controller set points

07. Conclusion

Our project exceeded CO2 absorption targets, reaching over 1200 ppm in water. Achieved calcium carbonate conversion rates of up to 97.2% and maintained stable pH ranges with rapid steady-state time. Future research should focus on CO2 mineralization for continued advancements in sustainability.

Mineral Formation