# Studies on the microstructure of carbon dioxide sequestered cement paste.

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## Abstract

The article presents the salient findings of research to investigate the effect of varying water-to-cement ratios on $CO_2$ sequestration in cement paste. Paste prepared using Ordinary Portland cement and tap water has been carbonated using crushed dry ice added at 4% by weight of cement in the first method of carbonation and bubbling $CO_2$ gas directly into the mixing vessel as the second method. To study the influence of early-age carbonation on physical properties, setting time and compressive strength tests have been performed on 50mm cube specimens. Thermogravimetric analysis (TGA), X-ray Diffraction (XRD), and pH measurements have all been used to examine changes in the composition of the hardened cement paste caused by the aforementioned processes. The chemical and morphological variations among non-carbonated and carbonated samples have been examined using Scanning Electron Microscopy (SEM).

**Keywords:** $CO_2$ sequestration, Carbon Dioxide, Cement Paste, Dry Ice, Chemical Characterization, Calcite precipitation.

## 1 Introduction

Greenhouse gas emissions that cause global warming have led to rising sea levels, abnormal temperatures, and increased natural disasters[1]. Among the greenhouse gases, $CO_2$ has been the most significant contributor. Industries such as chemical, cement, refining, thermal power plant, and steel are responsible for 50% of the emissions globally. Consequently, research aimed at reducing $CO_2$ emissions is being conducted in these industries, including carbon capture, utilization, and storage (CCUS) technology, which remains the primary method for reducing $CO_2$ emissions. This technology recognizes captured $CO_2$ as a reusable entity and recycles it. A typical CCUS method is mineral carbonation, which traps and stores greenhouse gases in the crystal structures of carbonate minerals like $CaCO_3$. Natural minerals or inorganic industrial waste products can interact with $CO_2$ that has been gathered from emission sources thanks to technology. Since carbonates, which are by-products of the carbonation reaction of $CO_2$, are thermodynamically stable and soluble and permit long-term $CO_2$ fixation, mineral carbonation technology provides advantages. [2].

Although carbonation can occur naturally during the production of concrete and aid in the absorption of $CO_2$ emissions, the process is too slow. It may take hundreds of years to fully absorb all emissions. It can also lead to the corrosion of steel reinforcements, ultimately harming the structure. While early-age cement carbonation using $CO_2$ can strengthen concrete and decrease porosity. Following are the basic chemical reactions



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