Steel slag wastes to fight the climate change

Sina Rezaei Gomari[1], Kamal Elyasi Gomari[2], David Hughes[3]
School of Computing, Engineering and Digital Technologies, Teesside University, United Kingdom
[1]Corresponding author
E-mail: [1]*s.rezaei-gomari@tees.ac.uk*, [2]*k.elyasigomari@tees.ac.uk*, [3]*d.j.hughes@tees.ac.uk*

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Abstract. Steel slags are solid by-products generated from the steel-manufacturing industries. They are considered valuable wastes for capturing of carbon dioxide (CO_2) directly from the air and industrial sources and storing it permanently in the form of mineral carbonation. In this study, two historic steel slags are presented as sustainable materials for mineral carbonation. The effects of contacting time between CO_2 and slags as well as temperature were investigated as two important parameters during mineral carbonation. The amount of carbonation, chemical and physical properties of carbonated samples have been characterised using Calcimeter, Fourier-transform infrared spectroscopy (FT-IR) and Scanning Electron Microscopy (SEM). The results showed that depending on the source and composition of the steel slags, the maximum CO_2 sequestration after 4 days at 60 °C is reached as high as 300 kg per tonne for samples. The FT-IR results showed the symmetric stretching of O-C-O bonds at 1400-1500 cm^{-1}, gradually increased with increasing temperature and contacting time, indicating the significant capture of CO_2 due to the carbonation process. SEM images confirmed that for both samples after the mineralisation, several carbonate layers were created in the structure of steel slags. The results indicated that CO_2 sequestration in steel slag is positively correlated with contacting time and temperature, hence the current study provides the optimal conditions to accelerate the process of carbonation for industrial application. It is estimated that these steel slags alone could carbonate about 150-200 million tonnes of CO_2 emissions which is equivalent to one third of annual UK greenhouse gas emissions.

Keywords: CO2 sequestration, steel slag, carbonate mineralisation, carbonate characterization, contact time impact, temperature impact.