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CO_2 trapping in calcium carbonate using aqueous solutions equilibrated with waste crushed concrete

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In pursuit of sustainable methods for removal of anthropogenic CO_2 from the atmosphere and safe, permanent storage/utilisation, we investigated a new concept for alkaline scrubbing. Aqueous solution made from waste crushed concrete is a high pH, cation rich solution that has high capacity for absorbing CO_2. Water-CO_2 equilibrium and the drive to form calcium carbonate at high pH favour trapping for CO_2 removal and permanent immobilisation – thus capture and storage in a single step.

The CO_2 uptake capacity of the solution (CO_2 loading) was estimated using PHREEQC. The PHREEQC input composition was determined with a spectrophotometer and a glass pH-electrode. The CO_2 molar flux from a 10% CO_2 gas (90% N_2) into the crushed concrete solution was determined experimentally by measuring precontact and postcontact pH of the solution with the total contact time. The chosen contacting scheme was single 2 mm droplets of the solution in a droplet chamber with the gas and the solution being at room pressure and temperature.

The theoretical CO_2 loading was found to be 0.25 mol CO_2 / mol solvent. Within the exposure time of 1.66 s the solvent reached 24% of its capacity. The CO_2 molar flux was found to be 1e-3 mol m^{-2} s^{-1}, which is promising with respect to capture contacting scheme feasibility and efficiency, considering a relatively low CO_2 concentration in the gas and operation at ambient conditions. CO_2 loading can be improved by increasing the crushed concrete-to-water ratio during the solution preparation, and fine-tuning the contacting scheme would increase the solvent performance. The products of the capturing process have the potential of being used as an additive in new concrete.