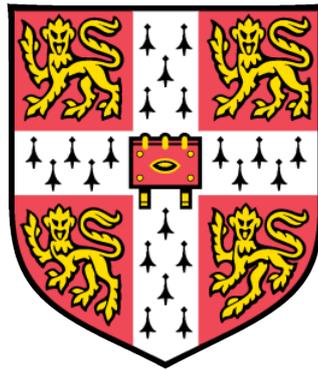


**Modification and performance of activated
carbon for CO₂ sequestration in pervious
concrete**



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Abstract

Concrete is the most frequently used material in the construction industry, with a global production of ~ 10 billion m^3/year . The production of Portland cement, the principal binder in most types of concrete, accounts for $\sim 5\text{--}7\%$ of global anthropogenic carbon dioxide (CO_2) emissions. Carbon capture and sequestration has been developed as one of several initiatives to help mitigate CO_2 emissions associated with cement and concrete production. Pervious concrete, a class of porous concretes, has been developed as a sustainable form of concrete that can be used for a wide range of applications. Its use is considered a 'Best Management Practice', recommended by the Environmental Protection Agency (EPA) to reduce storm water runoff, improve storm water quality and contribute to recharge of groundwater supplies. Activated carbon is a well-known adsorbent with a strong affinity for CO_2 , and its surface chemistry can be further modified to enhance its adsorption capacity. Therefore, this research investigates optimal methods for modifying activated carbon to incorporate within Portland cement-based pervious concrete, in order to enhance its CO_2 sequestration capacity and improve its overall sustainability.

Two forms of activated carbon (granular and powder) were purchased from Fisher Scientific (UK) and chemically modified using different concentrations of the impregnation agents (NaOH , HCl , $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, NH_4OH). The CO_2 adsorption capacity of the raw and the modified samples was measured using three techniques, which demonstrated that NaOH -modified samples had the highest capacity. A second round of modification was conducted to investigate whether further improvements were possible. A two-step process of modification, first with HCl , followed by NaOH was determined to produce the highest adsorption capacity in this process. Activated carbon modified with

this technique was used in three cementitious systems, which were tested in order to determine whether addition of such carbon adversely impacted important properties of the resultant materials. Modified powder activated carbon was used as a partial substitution for cement in cement pastes and pervious concrete, while modified granular activated carbon was used as a partial substitution to fine aggregate in cement mortars and pervious concrete. The investigation revealed that incorporation of small percentages of either form of modified activated carbon did not significantly alter the properties of the tested systems. Therefore, both substitutions were applied in pervious concrete to investigate the performance of modified activated carbon-pervious concrete in terms of CO₂ sequestration. The combined presence of the two forms of modified activated carbon had a minor effect on the compressive strength, porosity and permeability of the tested pervious concrete. Importantly, pervious concrete containing modified activated carbon had a higher CO₂ sequestration capacity than the control concrete. Furthermore, microstructural analysis showed that modified activated carbon-pervious concrete contained a higher content of calcite than the control concrete.

Overall, the addition of modified activated carbon to pervious concrete yielded promising results in terms of CO₂ sequestration. Further investigation of the long-term performance of modified activated carbon within pervious concrete systems is essential to realise the potential of this system to reduce atmospheric CO₂ levels and improve the sustainability of this essential construction material.