

Abstract

Unlike other carbon dioxide (CO₂) storage options, CO₂ storage in coal seams is still in its infancy, and one of the many questions that need to be answered concerns the long term effects of storing CO₂ in coal specifically on the structure and properties of the coal. Most studies on coal structural changes due to CO₂ adsorption have been done over the period of adsorption (hours or 2-3 days), and mostly at low pressures which are not representative of actual storage conditions. The aim of this study is to determine chemical and physical changes that might occur due to long term interaction of coal with CO₂ under pressurised conditions.

Air dried coal samples of different maceral groups (vitrinite and inertinite) were exposed to CO₂ in reactors under subcritical and supercritical conditions for different period of time (up to 6 months). The samples were well characterised pre- and post-CO₂ treatment. A newly-built high-pressure volumetric system was used for adsorption and desorption isotherms measurements of the coals before CO₂ sorption. The characterisation techniques used were BET, XRD, FTIR and ¹³C NMR.

Surface area analysis of untreated and treated coal particles showed that vitrinite-rich coal samples have a greater surface area and pore size distribution change in pore structure following CO₂ treatment than the inertinite-rich coal particles. Analysis of the crystalline part of the CO₂ untreated and treated inertinite-rich particles showed that there was slight increase in the average crystallite height following CO₂ treatment, although no changes were observed for the d₀₀₂ aromatic interplanar spacing.

In comparing the effects of subcritical and supercritical treatment on CO₂ sorption behaviour over time, the study determined that the long term effects of CO₂ storage in coal were found to be dependent on the maceral composition of the coal, with the vitrinite-rich coal showing a more pronounced structural and properties change after CO₂ storage. This change did, however, differ under subcritical and supercritical conditions. The adsorption capacity of the supercritical treated coal was found to be lower than the subcritical treated coal over the same period of 6 months for the vitrinite-rich coal. Inertinite-rich coal was found to be less prone to changes under CO₂ storage. A major implication of this finding is the inclusion of maceral composition as major criteria for determining CO₂ storage in coal capability.

The results in this study contribute significantly to the understanding of coal-CO₂ interactions and the implications for coal structure and properties changes; the results could be used by decision-makers on the effects of storing CO₂ in coal.