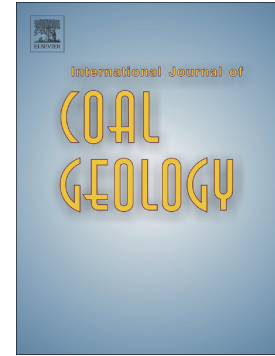


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Application of the stretched exponential equation to sorption of mine gases and sorption induced swelling of bituminous coal

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Abstract

An evaluation of the ability of the stretched exponential (SE) equation to describe the sorption kinetics and the rate of expansion/contraction of hard coal in coal–carbon dioxide, coal–methane and coal–CO₂/CH₄ mixture systems was performed. In order to address this issue the adequate sorption experiments were carried out at high pressure by means of the volumetric method on a cuboidal solid samples. Simultaneously the kinetics of coal sorption–induced swelling were monitored. For two coals under investigation a linear and a non-linear relation between coal expansion and the amount of sorbed gas was observed. The SE equation shows a very good agreement with the sorption experimental data obtained for both coals, it is also able to accurately describe the sorption-induced–swelling of lower rank coal and the CH₄–induced swelling of higher rank coal however it does not give a reasonable fit to swelling kinetics induced by sorption of CO₂ and CO₂/CH₄ mixtures on higher rank coal. The highest characteristic rate parameter k was found for CO₂ sorption on lower rank coal, the lowest was calculated for CH₄ sorption on the same coal and the values of k for higher rank coal are in between. The values of stretching parameter b for higher rank coal are greater than for lower rank coal, i.e. between 0.55 and 0.75 and less than 0.5, indicating a relatively narrow and a relatively broad distribution of characteristic relaxation times of sorption processes, respectively. Generally, the values of parameters k and b calculated for CO₂, CH₄ and CO₂/CH₄ mixture sorption–induced swelling are lower for lower rank coal. The values of parameter b for swelling phenomena are not compatible with these of sorption processes.

Keywords

Sorption kinetics

Coal swelling

Methane

Carbon dioxide

Stretched exponential (SE) equation

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