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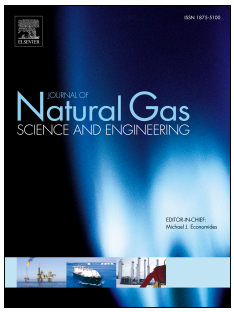

Impact of creep on the evolution of coal permeability and gas drainage performance

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IMPACT OF CREEP ON THE EVOLUTION OF COAL PERMEABILITY AND GAS DRAINAGE PERFORMANCE

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Abstract

Coal permeability changes during the course of gas drainage process due to the change in pore pressure, porosity, and desorption. Understanding of coal permeability behaviour enables a better assessment of gas drainage performance. Despite the research carried out to investigate the factors affecting coal permeability, limited study has been conducted on the impact of creep on coal permeability evolution. As coal is generally soft and gas drainage is a lengthy process, the impact of creep on permeability variation can be quite significant.

In this study, an improved permeability model was developed by incorporating the viscoelastic creep term of Nishihara model into the constitutive stress-strain equation for anisotropic poroelastic media. The model was then implemented in a fully coupled Finite Element numerical model. Two scenarios under various stress and uniaxial strain conditions were simulated to investigate the impact of creep on coal permeability and gas drainage. A comparison between the results of the simulation of the improved permeability model and the original permeability model were performed.

The results show that creep can have a significant impact (up to 25% or more) on coal permeability and gas drainage. This impact is function of coal properties such as directional elastic and viscoelastic moduli and reduction of pore pressure due to continuous desorption of gas. Comparison of improved and original models show that the impact of compaction creep on coal permeability becomes more pronounced owing to further pressure depletion toward the end of gas drainage process. It is also evident that the viscoelastic compaction creep as a result of gas pressure reduction from 6 MPa to 4 MPa induces a 5% decrease in permeability. A reduction of 13% in permeability was also achieved for pressure reduction of 4 MPa (from 6 MPa to 2 MPa). This indicates that coal permeability could be significantly overestimated if the impact of creep was not considered. The time and viscosity coefficient associated with creep was found to have negligible impact on coal permeability. This study proved that creep in coal is an important phenomenon that should be considered when conducting gas drainage