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Chaotic behaviour of acoustic emission induced in hard coal by gas sorption-desorption

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A b s t r a c t

This paper presents study of non-linear dynamics of acoustic emission (AE) generated in coal samples subjected to gas sorption-desorption. Carbon-dioxide and methane were used as sorbats. Experimental facilities used in high pressure sorption of CO_2 and/or CH_4 on coal comprised a pressure vessel and associated pressurisation and monitoring systems. Tests were conducted on medium-rank coal obtained from the Upper Silesia Basin.

Several approaches to the treatment of experimental results are proposed in order to detect and characterize deterministic chaos: (1) analysis of fractal/multifractal character of AE energy rate, using fractal generalised dimensions $D_q(q)$; (2) analysis of temporal changes of AE energy rate and its fractal correlation dimension D_2; and (3) evaluation of attractor dimension within the reconstructed phase space from experimental time series.

It was shown that AE generated during CO_2 sorption on medium-rank coal is a more heterogeneous and lower dimensional process in comparison with AE induced by CO_2 desorption. Yet, the AE associated with desorption of CO_2 exhibits higher heterogeneity than the AE generated during desorption of CH_4.

There are certain similarities between changes of D_2 during desorption of CO_2 as well desorption of CH_4. However, dynamics of these changes and character of time distributions of D_2 differ, depending on a sorbate. We do not know the precise reason for observed differences, but we presume that the carbon-dioxide molecules dissimilarity to methane molecules can account for them.

Key words: acoustic emission, chaos, non-linear dynamics, hard coal, sorption of gas.

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