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Mechanical system of coal and gas outburst

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Coal and gas outburst (CGO) is a dynamic geo-disaster that may occur during mining and tunnel excavations in coal mines. This phenomenon, considered a mechanical system, was investigated by system approach of its structure characteristics and evolution, on which a localization theory of CGO was proposed.

There are three size scales for the structure of a CGO system: meso-scale, engineering scale and regional geology scale. In meso-structures of the system, the tectonic coal was defined as a two-phase material combined by gas and coal, which is different from the traditional definition, only formed by coal. Here we classify six types, with different geological genesis and outburst properties. The format is as following: (ductile or brittle) + (gas and/or strength) + (tectonic coal) [1]. The type of tectonic coal may indicate its outburst proneness. On the engineering scale, the mining outburst system could be divided into two different structures, the outburst system in coal seam and outside the coal seam. They are chief structures of an outburst system, which contains the tectonic coal, the free work face and other boundary conditions. A two-body structure is formed by the hard wall rock and the soft coal seam within the chief structure of the system, which has a strong burst effect[2]. On a regional geology level, the primitive geological process and the tectonics would control the properties and distributions of tectonic coal and may also influence the boundary conditions of the system greatly.

The mechanical evolution of the outburst system, that is the mechanical mechanism of CGO, is a destabilization and failure process of a coal seam that has outburst proneness. The outburst process can be distinguished with two consecutive stages, the start of outburst and the development of outburst. The tectonic coal would deform drastically in a localized zone by shearing stress under action from in-situ stress and different boundaries. The formation of localized zone starts the outburst. This leads immediately great elastic energy release from the hard of two-body structure, which would in turn to burst the soft, the coal seam. Then the entire system is destroyed. That is the development of outburst. A new mechanical formulation was given to decide whether the system remains stable or go to destruction. It is concluded that all factors influenced the outburst process, are of no ways but acting as part of the system structure, or changing its properties or boundary conditions.

It is vital to investigate CGO systematically and distinguish its evolution stages and structure scales before giving reasonable explanation to one of the complex phenomena of CGO. It is also the base for making effective measures to prevent or predict CGO.

References:

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