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# COUPLED MULTI-STAGE OXIDATION AND THERMODYNAMIC PROCESS IN COAL-BEARING STRATA UNDER SPONTANEOUS COMBUSTION CONDITION

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## ABSTRACT

Spontaneous combustion of subsurface coal is an extremely complicated chemical and physical changing process. In order to quantitatively understand the development of underground coal fires, the heat transfer processes coupled with multi-stage oxidation of coal are investigated by experimental and numerical methods in this paper. With controlled temperature and under lean oxygen conditions, the chemical thermodynamic parameters of coal oxidation on different stages are measured utilizing the simultaneous thermo gravimetric analysis. Employing the composite boundary conditions, a heat transfer model with finite reactions for porous coal and rock is developed to simulate the thermal dynamical process in coal-bearing strata. The temperature fields of coal and roof strata at different times are estimated based on single- and two-stage oxidation kinetic models, respectively. The effects of the oxidation kinetic properties due to coal metamorphism on propagation of coal fires are examined and compared. It demonstrates that there exists a significant step change during the thermal process of coal fire caused by multi-stage oxidation, and the coal rank of occurrence directly determines the spontaneous combustion period of underground coal fire.