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## Distribution Regularity and Numerical Simulation Study on the Coal Spontaneous Combustion “three zones” Under the Ventilation Type of $\Psi + J$

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### Abstract

Taking Wang Tai Coal Mine 2304 working surface as the object of study, the gaseous components along with the advancing working face were examined through burying pipe sampling in the goaf, the change rule of oxygen volume fraction along with the depth of working face was investigated. According to the measure result of gas concentrations, this paper determined the distribution of coal spontaneous combustion oxidation “three zones” in Wang Tai Coal 2304 working face. At the same time, based on the Darcy law, the numerical simulation was performed for the single return air roadway by using the Fluent software, 80m, 160m and 240m away from the working surface respectively. In the three situations, the paper researched the distribution of flow field, the O<sub>2</sub> concentration field and the CO concentration field, analyzed the change rule of oxidation zone along with the advancing working face. Wang Tai Coal 2304 working face contain spontaneous combustion “three zones”: cooling zone (0~38m), oxidation zone (38m~145m) and suffocation zone (> 145m); the width of oxidation zone along with single return air roadway from the face length approximately linearly increases.

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### 1. Introduction

In the process of mining, oxygen concentration emission reduced when the coal is oxidized and the gas was diluted in the gob, at the same time, because the air leakage can make the oxygen receive to supply, therefore, in the gob, it formed "three zones" with a cooling zone, an oxidation zone and a

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suffocation zone<sup>[1]</sup>. The extent and distribution patterns of the "Three zones" is not only the important genetic basic parameters for controlling the spontaneous combustion of the coal mine, the analysis of spontaneous combustion main basis for early growth, but also providing a strong basis for fire prevention and control<sup>[2]</sup>. At present, a large amount of research was carried out on the "three zones" in domestic and abroad<sup>[1,3-6]</sup>, it mainly contain the extreme wind speed criteria method, the oxygen concentration method and temperature method. Based on the method of oxygen concentration, the 2034 surface mining of coal combustion distribution "three zones" was observed. According to the Darcy law, a single return air distance of working face about the 80m, 160m and 240m distribution of oxygen concentration, CO concentration field and the change flow under this three cases simulation were studied by using the FLUENT software.

## 2. "Three zones" Observation

### 2.1. Face Profile

The 2305 working face is being arranged in the north of the 2304 face, the village of protection pillar is in the south, the 2107 and 2108 roadway locate in the east. The thickness of 2304 working face is 1.80m ~ 2.61m, and average mining height is 2.26m, the seam dip is between 1° and 5°, the average angle is 3°, the density is 1.46t/m<sup>3</sup>. The immediate roof of the seam is the K<sub>1</sub> limestone and it belongs to the hard roof. A large number of coal pyrite was contained in it, and the top part is the calcite veins. The gas absolute emission is 1.00 ~ 2.52 m<sup>3</sup>/min in the working face. The absolute amount of carbon dioxide emission is 0.75 ~ 1.51 m<sup>3</sup>/min. The volatile index is among 6 ~ 8%, less than 10%, and the flame length is zero, there is no coal dust explosion hazard. Roadway arrangement as follows: roadway 2207 is used for offering the wind, transport coal, offering the electricity, liquid and removing water; roadway 2208 is used for offering the wind, transportation, drainage; roadway 2209 is used for returning air, and they are formed  $\text{ч} + \text{J}$  ventilation.

### 2.2. "Three zones" observation method and the arrangement of test points

The main observed content of the gob spontaneous combustion "three zones" is to determine the spontaneous combustion scope. The beam pipe sampler is embedded in the gob, in order to detect the gas composition along with the changes in the promoting of mined areas face. According to the gas concentration, the cooling zone, spontaneous oxidation zone and suffocation zone are determined.

Gob gas composition was observed by pumping method. The gas sample was collected into the mining balloon from the gob through the pipeline, and then the gas composition was analysed by the gas chromatography in the laboratory.

The 2304 working face arrangement was shown in Fig 1. The beam pipe sampler was buried between the second and the fourth horizontal space, the front line was protected by the steel pipe, and the front part was located at 10m in the gob. The exhaust-side roadway was in 2209 and the two test tube observed at the same time. The mined area "three zones" distribution was determined according to the measured gas concentration along the elapsing of the work face.

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