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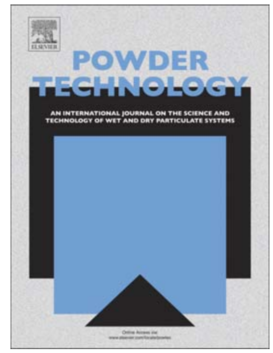

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Influence of diaphragm thickness on gas explosion suppression by vacuum chamber

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Abstract: In this study, a vacuum chamber is employed as a new method for suppressing gas explosions using a diaphragm, a device that separates the vacuum chamber from a gas pipe. After over-pressurization in the pipe breaks the diaphragm, the vacuum chamber plays a role in suppressing gas explosion. Notably, the performance of the diaphragm significantly influences the way in which gas explosion is suppressed by the vacuum chamber. To perform experiments for testing such effects, this study used the polytetrafluoroethylene films of 0.1 mm, 0.2 mm and 0.3 mm thickness as the vacuum chamber diaphragm. As the diaphragm thickness changed, the suppression effect on gas explosion varied. Vacuum chambers have an obvious influence on the propagation characteristics of explosion flame. When explosion flame spreads to a nearby vacuum chamber, the flame signal weakens, flame speed decreases, and flame thickness increases. Vacuum chambers can distinctly weaken an explosion's overpressure and impulse. The thinner the diaphragms, the greater the change in explosion flame parameters and the smaller the explosion overpressure and impulse. When using a thinner diaphragm, at the point at which the diaphragm disintegrates, the distance between the explosion flame front and vacuum chamber decreases, thereby increasing the explosion's flame stretch. Thus, the thinner the diaphragms, the better the overall explosion suppression.

Keywords: Vacuum chamber; Gas explosion; Diaphragm thickness; Explosion overpressure; Explosion flame; Explosion impulse

1. Introduction

Coalbed methane (CBM) has attracted significant interest as a low-carbon energy source. Proven CBM reserves in China are 37 trillion cubic meters, ranking third in the world. Unfortunately, Chinese CBM reservoirs have low permeability, low porosity, and high in-situ stress owing to the effects of complex geologic structures and burial conditions; thus, there is a low concentration of CBM (Cheng Zhai et al. 2015). In Chinese coal mines, the CBM concentration ranges from 20% to 70%. Because of such CBM concentration variations, CBM may easily fall within the conventionally established "explosion concentration range," thereby posing potentially serious safety hazards during transport and discharge. Such CBM gas explosion has occurred in Shanxi, Chongqin, Anhui, and Yunnan. (Huo Chunxiu 2014).

A method usually implemented to suppress CBM pipe explosions is to spray explosion suppression materials into a potential gas explosion reaction area in a timely manner. At present, effective suppression materials (as verified by experiments) include water mist, inert gases, inert dust, and cellular materials. A significant decrease of H, O, and OH contents in the flame front can inhibit gas explosions caused by the presence of water (Liang and Zeng 2010). The grain size of

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