

矿井CH₄和煤尘的光声复合检测方法研究

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摘要:

煤矿瓦斯(CH₄)爆炸常常与煤尘爆炸相互伴随发生, 以往CH₄和煤尘的浓度都是分开检测, 不利于煤矿瓦斯煤尘爆炸的准确预测。本文利用气体滤波光声技术和光散射原理对矿井气体中CH₄和煤尘质量浓度进行复合测量。分别采用两个气体滤波光声腔作为CH₄测量光声腔和煤尘参比光声腔(CO测量光声腔), 在光源和光声腔之间建立CH₄和煤尘的测量腔, 记录其进入该测量腔后光声信号强度的变化, 通过对两个滤波波长上CH₄吸收和煤尘颗粒消光的相关处理, 同时得到CH₄浓度和煤尘质量浓度。实验数据表明, 光声复合检测方法可以对CH₄和煤尘质量浓度进行准确检测, 准确度达到10⁻⁴数量级。

关键词: 光声技术; 气体滤波技术; 粒子散射; CH₄; 煤尘

Photoacoustic Combined Method Research Sensing for Methane and Coal Dust in the Mine

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Abstract:

The gas (CH₄) explosion and dust explosion often happened with each other in coal mine. The concentration of CH₄ and coal dust was detected separately in the past, which were bad for coal mine gas and coal dust explosion accurately forecast. This paper presents a photoacoustic method to meter CH₄ and dust concentration simultaneously in the mine gas. The mine gas, including gaseous components and dust particles, were metered in the measuring cell between the light source and the photoacoustic cells. Based on gas filter technology and particle scattering theory, a CH₄ gas cell and a reference gas cell (CO gas cell) were used together to meter the light attenuation caused by CH₄ absorption and dust particles extinction at two different wavelengths. When the mine gas and coal dust entered the measuring cell, CH₄ concentration and dust optical density were obtained by processing the photoacoustic signal attenuation of the two cells. The experimental data show that the photoacoustic combined method can sense for CH₄ and dust particles more accurately. Accuracy can be achieved 10⁻⁴ Orders of magnitude.

Keywords: photoacoustic technology; gas filter technology; particle scattering theory; CH₄; coal dust

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