The Australian Mine Ventilation Conference 2017

Paper Number: 92

New generation of gas sensors for underground mining applications

B M Masum[1], S M Aminossadati, C R Leonardi, M Amanzadeh

1.
School of Mechanical and Mining Engineering, The University of Queensland, Australia

ABSTRACT

Gas sensing systems form a crucial component of monitoring systems in many applications such as oil, gas and mining industries. In the context of underground mining, effective monitoring of toxic and combustible gases such as methane, nitrogen dioxide, carbon monoxide and hydrogen sulphide is essential. Electronic based sensors and gas chromatography are currently utilised in telemetric and tube-bundle monitoring systems. However, these sensors are subject to major disadvantages such as cross-sensitivity, limited lifetime, high maintenance cost and installation complexity when applied in mining environments.

Fibre-optic based gas sensing systems can eliminate some of the disadvantages of conventional gas sensors. In addition, fibre-optic based gas sensors can be used for long distance and distributed gas measurement, both of which are important in underground mining applications. Recently, the potential of Hollow-Core Photonic Crystal Fibre (HC-PCF) in highly sensitive and distributed gas spectroscopy applications has been demonstrated. HC-PCF is an optical fibre with a hollow core that is surrounded by a number of periodic air holes. These periodic air holes work as cladding and trap over 99% of light in the core. The core is an empty space where gas is able to enter and directly interact with light, which is required for gas spectroscopy.

Response time is an important parameter when the performance of a gas sensor is studied, with faster times typically favourable. The response time of HC-PCF is dependent on the filling and evacuation time associated with gas transport between the environment and the core of the fibre. Laterally-drilled holes present in HC-PCF improves gas access to the core and decrease the response time. However, the spacing and design of laterally-drilled holes should be carefully determined in order to minimise the response time and optical loss, simultaneously. It is essential to understand the mechanisms of gas flow in drilled HC-PCF in order to determine the spacing and design of these side holes. Therefore, the aim of this paper is to develop a computational fluid dynamics model to examine the gas flow behaviour in the drilled HC-PCF. The model includes a HC-PCF (HC-1550-02) with 10 μm core diameter and a 10 μm diameter single side hole. The numerical model was validated with experimental results for methane sensing in terms of response time and gas concentration measurement.

The Australian Mine Ventilation Conference 2017

Paper Number: 17

Cutting ventilation air methane emissions cheaply and safely

R I Holmes[1]

1.
PhD Candidate, Federation University, Science & Engineering bldg, Victoria, Australia.

ABSTRACT

Methane has been controlled in collieries in the past only for safety and statutory compliance reasons; however, concerns over greenhouse gas emissions mean that this is now changing. About 65% of greenhouse emissions associated with underground coal mining come from ventilation air methane (VAM). The machinery to mitigate these fugitive emissions once the VAM exits the mine fans is expensive, has safety concerns and is not widely used at present. Consider these factors; more collieries are mining lower seams, methane content increases with depth, VAM mitigation plants are not widely used, most mine emissions are VAM, and widespread concern over greenhouse gases mean that it is desirable to lower VAM emissions now. One solution would be a method to prevent more methane from entering the mine airstream and becoming VAM in the first place. Recently, in a colliery in the Hunter Valley, this mitigation method underwent a 12-month trial, and involved six different measures. Measurements were taken to assess the emissions mitigation which was achieved, and the cost of the works; all the results are detailed herein. A reduction in fugitive emissions of 80,307 t/CO_2-e below that which was projected for the next 12-month period was quantified, at an average cost of A$1.28c t/$CO_2$-e. The mitigation measure outlined here represent a first attempt to the author's knowledge, in an operating mine, to lower a collieries' environmental footprint by preventing methane from entering the mine airstream and becoming VAM gas by the deliberate use of mitigation measures. If this method were to be extended to all Australia's collieries, a mitigation total of 3mt/CO_2-e/yr should be possible.