Optically Powered Monitoring Networks

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ABSTRACT

We developed an **optically powered, intrinsically safe** gas monitoring system to measure four essential environmental gases (CH₄, CO₂, CO and O₂), ambient temperature and pressure for underground mines (see Figure 1 below).

The system consists of two gas monitoring stations designed to be installed underground and of a remote terminal unit (RTU) on the surface connected to the local network via Ethernet. The gas monitoring stations are **entirely powered optically** by the light sent from the RTU and transmit all sensor information optically back to the RTU via the **same** optical path. The signal is then converted to digital electrical signal for data logging and webpage display.

The system is based on two key optical technologies developed at UNSW: (1) power-over-fibre (PoF) at 1550 nm using a single industry-standard, low cost single-mode fibre (SMF) for both power delivery and information transmission, and (2) liquid-crystal-based optical transducers for optical telemetry. The ultra-low power consumption design of the electronics and data transmission approach allows each gas monitoring station to operate with less than 150 mW optical power, meeting the intrinsic safety requirement (IEC60079-28).

Compared with conventional electrically powered gas sensors, this technology bypasses the usual roadblocks of underground gas monitoring where electrical power is either unsafe or unavailable. Furthermore, using one fibre for both power delivery and data transmission enables longer distance coverage, reduces optical cabling and increases multiplexing possibilities.

A 2-month field trial at BMA's Broadmeadow underground mine proved the cabling compatibility to the mine's existing optical network and the stability of the system performance.

This paper details the most salient aspects of the approach taken and the latest development implemented following the field trial. Although this project focussed on gas monitoring, we foresee the technology presented as enabling new and better monitoring approaches especially under conditions where intrinsically safe monitoring over large areas (or long distances) are required.



Figure 1. Intrinsically safe, optically powered gas monitoring system. This exact system was deployed on December 17, 2020 at the BMA-operated mine of Broadmeadow.