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ACARP MATTERS

NEW SYSTEM AIDS EFFECTIVE AND RAPID MANAGEMENT OF UNDERGROUND MINE HEATINGS

Hazardous situations in underground coal mines can now be rapidly identified and remotely monitored using a robust, lightweight probe system deployed down boreholes.

Developed by Minerals Industry Safety and Health Centre (MISHC), University of Queensland, Associate Professor David Cliff and Geotechnical Systems Australia Instrument Consultant, John Lakeland over three consecutive ACARP projects, the modified commercial sewer pipe inspection system can be deployed via a 100-millimetre diameter, uncased borehole and view areas up to 25 metres away from the base of the borehole.

"This device, especially configured for the specific conditions expected at Australian coal mines, now provides the industry with the means to gather much more relevant data in the early stages of mine emergencies."

Industry Monitor,
Bruce Robertson, AAMC

The system consists of a camera module fitted with two cameras (downhole and perpendicular to the hole) with variable intensity lighting, a module that contains the sensors (air velocity, air pressure, air temperature, infrared surface temperature and oxygen), and a power pack and control module. The sensor pack also contains a microphone, speaker and compass to identify the direction the camera is facing. The modules are connected via fibre optic to the surface and the full probe assembly weighs about 35 kilograms. The camera and power supply modules are waterproof to 1000 metres and are filled with nitrogen. In addition, there is no power delivered from the surface. The complete system is portable and was successfully deployed to Moranbah North in 2008 within eight hours.

The probe has undergone a series of field trials (including at Newstan, Austar, and Newcastle Mines Rescue Station) and subsequent modifications. During these trials gas concentrations, temperature and pressure near the base of the borehole were successfully monitored. Mine personnel were able to identify where the gas samples were coming from, monitor the state of seals into goafs, follow the progress of flyash injection to form seals, inspect the state of sealed areas and identify otherwise unknown roof falls and ribspall, as well as identify the origin of spontaneous combustion.

The probe is based at Geotech's facilities in Melbourne. It is available for routine use at commercial rates and can be deployed in emergency situations anywhere in Australia within 24 hours. Geotech is also able to construct probes for individual companies who would like the system tailored to their own needs.

Geotech recently inspected a subsiding ventilation shaft in the Hunter Valley using the probe while the fan was operating. The probe demonstrated that it was well suited for use in old mine subsidence investigation.

David Cliff said the incremental approach to this project had optimised the potential for successful outcomes while minimising the cost and risk. The final phase of the project built on the success of the previous phases and utilised existing technology in innovative ways.

"Over the three phases of the project we were able to identify and solve a range of problems and prioritise the capabilities that were identified by industry as being important. Once the basic system was constructed we were able to demonstrate the benefits of using such a system and then move on to refining and improving the system, focusing on increased capacity (greater depth) and robustness, as well as portability," he said.

"After the first two phases of the research it became evident that modifying a commercial system would be a cost effective solution and offer a high quality device. It is a much more robust system than the ones we were able to construct ourselves. It utilises fibre optic technology which allowed us to extend the depth that the camera could go to over 1,000 metres. The whole system can be dismantled and shipped easily in robust containers and quickly reassembled – as in the deployment to Moranbah North.

"It is also able to embody a capacity to undertake other measurements at the same time with special modules such as gas concentrations, barometric pressure and air flow. It would be possible to develop other modules for other tasks such as stress measurements, infrared photography and cavity profiling."

David Cliff said sourcing a suitable camera for the probe was an important issue.

“The Gullyver company in Germany has been making sewer cameras for many years and is a leader in this field. The team offered to modify its system to our needs. The price was similar or lower than other organisations but Gullyver was much keener to do business and tailor the system to our needs. They actively worked with us to develop and test the system,” he said.

In addition to meeting its objective to develop an investigation tool for use in sealed or inaccessible areas of underground coal mines, the probe has proven useful in assessing subsidence above coal mine workings, identifying subsidence cracks and areas of compaction and non-compaction. A number of mine shafts were inspected. The probe has also been able to identify problems that would not be obvious without visual inspection such as blocked boreholes, roof falls and water inflows. For example, it was used at Newstan to determine the state of the goaf and roadways, including a number of major roof falls and the quality of goaf seals. It is designed to be deployed through small, 100-millimetre diameter boreholes which are much quicker to drill compared with 150-millimetre diameter boreholes. Industry monitor Bruce Robertson hailed the commercialisation of the borehole probe as a breakthrough in mine safety for underground coal mines.

“Over many incidents at mines over the years, mine managers and incident controllers have yearned for the ability to quickly interrogate conditions at specific locations in underground mines via slim boreholes to obtain critical incident data to support control initiatives and rescue and recovery processes,” he said.

“This device, especially configured for the specific conditions expected at Australian coal mines, now provides the industry with the means to gather much more relevant data in the early stages of mine emergencies. It also puts at the disposal of technical and operations staff the means to supplement traditional datasets for geotechnical and ventilation studies.”

This project was initiated in 2002 in order to develop a tool that could be deployed via a borehole to investigate sealed or inaccessible areas of underground coal mines. In the past, once a mine had been evacuated there was no reliable way of remotely identifying the source of a heating or investigating abnormal gas concentrations in a goaf, unless a number of boreholes were drilled. This is an expensive process. Direct access for investigation requires demonstration that it is safe to re-enter. These boreholes can also be used for inertisation and injection of fly ash and other blanketing materials. It is therefore important to ensure that the borehole is in the correct place in relation to the source of the heating. There have been many past instances where inertisation via boreholes has been unsuccessful due to loss of the inert material through cracks above the coal seam into other strata. The use of a camera to survey the hole would have been able to identify any issues and optimise the application of control measures.

In addition when assessing the stability of an area after undermining, subsidence can be assessed via coring of boreholes as well as measuring the surface contours. The stability of the area and the degree of subsidence is then inferred from core samples. Occasionally special, commercially available, in-hole cameras are used to scan the borehole to provide pictorial evidence. However, these cameras usually have limited optical range to less than 30 centimetres, are designed only to view the sides of boreholes, and are not equipped to carry out any other analysis such as temperature measurement or gas analysis. This technology is similar to pipeline inspection technology.

As a result of Cliff and Lakeland’s research, safety in underground mines will be improved by the application of the probe system through its ability to enhance the quality and quantity of information available to mine personnel. Improved interpretation will lead to faster, more reliable treatment. With fewer unknowns to deal with, managing heatings in underground mines will be safer.

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