FIRE IN THE DEEP

INERTISATION TECHNIQUES USED TO EXTINGUISH FIRES IN DEEP MINES ARE BLOWING INTO ROAD/RAIL TUNNELS.

Researchers estimate that deep-mine coal fires contribute a staggering 2-3% to global CO2 emissions, and this includes 40 tonnes of Mercury released into the atmosphere per year[1].

Considering that an out-of-control fire can easily burn for 30-40 years – if not longer, as there are mines that have been on fire for over 100 years – the financial and environmental toll is significant and unrecognised. Scientists are not able to assess how bad the problem is, given that many of the fires go unnoticed. However, it has been proven that human interference – such as in coal mining operations – greatly increase the chance of these types of fires.

Michel Kooij, MD of Dutch Company Steamexfire, explains that once a coal seam is exposed to oxygen, the coal undergoes a chemical reaction that releases heat, and often this can cause it to spontaneously combust. 'In many cases, workers in mines usually detect the fires themselves, since many mines are not equipped with detection systems, and the mine personnel use their own extinguishing methods to quench the fire. But when the fire goes out of control and there is a possibility of it settling in the coal seams, the experts need to be called in.'

Michel has developed a system called Steamexfire that makes it possible to quench a mine fire by inertisation. The Steamexfire is driven by a jet engine and produces a mixture of gases consisting of 65% water products (70% atomized water and 30% steam) and 35% gases (81% nitrogen, 13-15% carbon dioxide, 0.02 -0.05% carbon monoxide, and combustion gases).

These agents act together as an inert gas, and they are released at high-flow, at a temperature of approximately 80-90 °C. They cool the fire down and starve it of oxygen, eliminating two sides of the fire triangle.

Steamexfire comes in several different sizes and capacities, and is available as a fixed or mobile system. The Steamexfire 2,500 jet inertion system – suitable for mine and tunnel fires –is the largest in the range. Although it uses 2,000 litres of kerosene per hour, adding up to 480,000 litres per day, it produces a massive 25 m^3 of inert gas per second. Even considering that mine fires tend to last from several weeks to several months – or maybe even years – this might appear a costly solution. Michel however emphasizes that this is certainly not the case when taking into account the cost of daily production loss or closure of the mine.

The Steamexfire is for sale as a standalone unit, or can be hired with the additional expertise of the first response team. Michel has one large; two middle-sized; and one small system on standby, all if which can be airlifted to major mine fires all over the world within 24-hours by Boeing, Hercules or Antonov plane. He says that when an alarm call comes in, the fire will usually have been burning for several weeks, because the mine personnel will have tried every avenue to extinguish the fire, such as with high-ex foam and water.

'When I arrive at a mine, I usually sit around the table with the mine management and a mine ventilation specialist. Together we assess the situation, and create a quenching strategy. If we have decided that the Steamexfire is the right option to deal with the situation, we have to get a connection at the right entry point – this is usually through the ventilation shaft nearest to the seat of the fire. However, this could still be 3-5 km away from the insertion point. In many cases, the space that needs to be inerted is over 500 metres long and 300 metres high. After the cavern is totally sealed, we can start pumping in the inert gas mixture.'

It took the Steamex 18 days to quench the fire.

During this process, it is essential to take constant samples of the gas in the mine with a gas chromatograph to monitor the pressure in the mine caused by the build-up of combustion gases. The samples are taken via bore holes, and

The Steamex is powering its way into the field of road/rail tunnel fires. Tests have been conducted with the Dutch Ministry of Environment and Technology and test institute TNO in the Hubertus Tunnel, in The Hague (Netherlands).

if they are found to be positive then it is time to ventilate the combustion gases, and flush the mine with inert gas until the fire is quenched.

One of the large incidents that Michel and his response team attended was a major fire on the Island of Spitzbergen in the Svea Nort mine, operated by Store Norske Spitzbergen Kulkompani in 2005. The mine is located between Norway and the North Pole, and is one of the largest coal producers in Europe, with an output in 2009 of 2.6 million tonnes. The fire had already been going for over five weeks, causing 700 million Norwegian kroner worth of damage. It took the Steamexfire 18 days to quench the fire in one of the underground vaults, and seeing that there was a glacier on top of the mine, large quantities of steam mixed with methane were escaping through the seams.

Michel explains that inertisation is widely accepted in the mining industry and the inertisation jet engine has been used in many major mine fires all over the world, including the Goedehoop mine fire in South Africa.

Taking the step from mines to road/rail tunnels wasn't a large one for the company. The new inflatable Tunnel Plug makes it possible to create compartments in tunnels within a time frame of seven minutes. After the tunnel is sealed off, the Steamex is used to pump the compartment full of inert gas and extinguish the fire. 'It is essential that the tunnel is sealed as airtight as possible, and therefore we do need a design drawing of the tunnel. This is a new concept and we have carried out tests with Rijkswaterstaat (Dutch Ministry of Environment and Ecology) and TNO (a testing institute) in the Hubertus tunnel in The Hague in 2008 (NL). The test was conducted by placing a mobile Steamexfire system on a trailer just in front of the tunnel entrance, and connecting it to the tunnelplug by using sections of pipework. After this, the tunnel, with a length of 1,500 metres, was inertised in various conditions and various performances.

'We are very happy to demonstrate the capabilities of our products, so we urge organizations to get in touch with us, so we can show how to use Steamexfire in other applications, such as for warehouses.'

Notes

(1) Rosema, A., Genderen, J. L. van, Schalke, H. J. W. G. and Beijing Remote Sensing Corporation (BRSC), 1995, Environmental Monitoring of Coal Fires in North China. Project Identification Mission Report October 1993. Beleidscommissie Remote Sensing (BCRS) report 93-29 (Delft: BCRS), 25 p.

UNDERGROUND POWER

It is a little known fact that in the next decade current electricity generating capacity is going to be placed under significant stress. In the UK alone, shortly after 2015 the National Grid will see 11GW of coal and oil-fired generation close at the same time as significant wind resources enter the electrical utility system. Some expect that generation safety margins will drop below safe norms, and brownouts – or even blackouts – could become quite common.

Factoring in the expected occasional local power cut lasting several hours (or even days) into the equation, and assuming that accidents do happen underground (which may leave miners lacking power), the incentive to secure electrical power for mission critical mining equipment running on 230V AC becomes rather compelling.

This issue of power invariability is not just an issue for the UK; other countries around the world may also suffer similar power shortages – including some of the major mining nations.

The old-fashioned way of guaranteeing the availability of electrical power was by installing an engine driven generator as a standby. However, there are numerous issues that need to be overcome not forgetting where to install the generator. Some of the issues which need to be overcome are:

- Ventilation: a 10kW generator gives off approximately 20kW of heat and therefore a surface installation is required meaning, in many cases, that significant extra cabling costs are incurred.
- Fuel storage: diesel fuel gives off fumes that require special storage measures because a leak could result in fire. The use of petrol creates even more safety concerns.
- Cost: even though generators are competitively priced, the installation and on-going service can be expensive. This is because of special siting requirements; they often have to be sited away from the load.
- Siting: it is not always possible to site a generator due to industry fire/explosion regulations, planning rules, or even a lack of space.

Graham Chapman of the UK-based Power Systems Warehouse – an electronics company specialising in the design and manufacture of power management solutions – says one solution is the Silent Mains Standby System, which automatically provides 230V AC mains electrical power when the utility supply fails, for at least four hours. The SMSS needs little ventilation, can be sited underground, is electrically powered, and operates silently.