Wendy Pyper

Hybrid turbine mines power from waste

A new hybrid turbine system that uses reject coal and methane gas to generate electricity could help 'green' the mining industry and reduce Australia's greenhouse gas emissions.

Developed by CSIRO Exploration and Mining, in collaboration with the Liquatech Turbine Company and the New South Wales Sustainable Energy Development Authority, the technology could convert thousands of tonnes of high ash reject coal and its associated methane emissions into enough power to sustain Australia's population for 10 years. In doing so, the technology will help reduce Australia's greenhouse gas emissions by about 5%.

'Australia's underground coal mines each typically produce some 800 000 tonnes of reject coal a year,' says CSIRO process research engineer, and 'co-mastermind' behind the turbine, Dr Patrick Glynn.

'The coal is full of pockets of methane gas, which escapes into the mine ventilation air and makes up about 5.7% of our greenhouse gas emissions. But if the reject coal is not treated properly (covered with clay or other material to exclude air), it can spontaneously combust and emit a further unknown percentage of greenhouse gas.'

As a greenhouse gas, methane is 21 times more potent than carbon dioxide. The coal industry has unsuccessfully explored many options for removing methane from ventilation air, but at such low and fluctuating concentrations it cannot be burnt, or used to generate power. However, the recently completed 1.2 megawatt coal and gas pilot plant built at the Queensland Centre for Advanced Technologies appears to overcome these problems.

'Air containing the methane gas is combined with reject coal in a rotating kiln,' explains Glynn. 'As the coal burns, its hot surface area mixes with the low concentration methane and burns it. So you end up with hot exhaust gas – up to 1300°C – and the products of combustion: carbon dioxide and nitrogen.

'The hot exhaust gas then passes through a heat exchanger, where it transfers its heat to the compressed air from the gas turbine compressor. This air expands and spins the turbine to generate electricity.'

If methane levels in the kiln fluctuate, more waste coal is added from the mine waste stockpile, levelling out the energy from the burning coal and methane to produce a constant fuel supply necessary for generating power. The result is a simple, flexible and inexpensive process, producing electricity that can be used to power the mines' own operations, with the surplus fed back into the power grid for general consumption.

Glynn says the gas turbine system is potentially 4–10% more efficient than conventional power stations, which lose more energy in the conversion of water to steam. The system may also attract carbon credits, providing incentive for adoption of the technology, and speeding the timeframe in which capital costs can be recouped.

The system can even offer value-added products and services, such as light expanded aggregate and water desalination.

Dr Patrick Glynn at the exhaust stack end of the rotating kiln. The pilot plant produces electricity from reject coal and the technology could be used to power mining operations.

'If you grind the reject coal into small nodules and coat them with a binder, such as clay, it comes out of the kiln as a very lightweight lava-like ash,' Glynn says.

'This expanded aggregate could be used to increase the strength of concrete house blocks by 30% and reduce their weight by 40%. It could also be used in the hydroponics industry, or scattered on the surface of dams to minimise evaporation.

'Alternatively, waste heat from the kiln could be used to drive a vapour pressure desalination unit. This would reduce the cost of desalination by 20–30%.'

The next step in the development process is to construct a 10 megawatt pilot plant at a mine site in New South Wales. This step will test the larger-scale application of the technology and industry acceptance.

If successful, larger plants could soon be using an otherwise wasted resource to boost Australia's energy and environmental standing. A worldwide patent now exists on the technology and, through a proposed CSIRO-Liquatech joint venture company, it may be introduced into Asia.

Early stages of the research were funded by CSIRO and the Australian Coal Association Research Program.

Contact: Patrick Glynn, (07) 3327 4636, patrick.glynn@csiro.au.

Wendy Pyper