Ventilation air methane: a simulation of an optimised process of abatement with power and cooling

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ABSTRACT

Ventilation air methane (VAM) is ultra-low concentration methane emitted from a coal mine. This is a consequence of the high ventilation air volumes (up to 600 m^3/s) that is circulated though the mine to ensure that the methane remains below the flammability limit. The VAM enters the atmosphere and contributes to anthropogenic climate change. In 2016, the Australian Government reported that approximately 53 % of these fugitive emissions were from underground coal mines. The abatement of VAM therefore becomes important.

The abatement of VAM in a fluidised-bed reactor where the process heat was recovered to produce power in a Brayton cycle (gas turbine) and cooling via absorption chillers has been discussed in earlier work. The process was simulated using Aspen Plus software to determine the minimum methane concentration to operate the plant and concurrently maintain the oxidation of methane. However, a condensing recuperator and low temperature gas expansion was considered. This work describes an optimised process of heat recovery from the fluidised-bed VAM abatement reactor and the production of power and cooling. Preliminary results show that for a ventilation flow rate of 20 m^3/s (equivalent to a single abatement unit), the minimum methane concentration for the direct Brayton cycle was 0.45 vol. % at a reactor temperature of 630 °C and reactor pressure of 1.5 bar.

The abatement process is modular and would require 30 units for the ventilation flow of 600 m^3/s. At 0.45 vol. % a total of 12 300 kW_R of cooling would be produced, which is sufficient to meet the cooling requirement (with standby capacity) for the typical gassy coal mine in the Bowen Basin of Queensland (7 000 kW_R). Furthermore, this translates into an operating cost saving of $ 1.1 M.