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Using Ventilation Air Methane (VAM) as Combustion Air in Reciprocating Engines and Turbines

Appin Power Plant, New South Wales, uses VAM as combustion air in its IC engines
(Photo courtesy of Energy Developments Limited)

A Proven Technology for Use of VAM

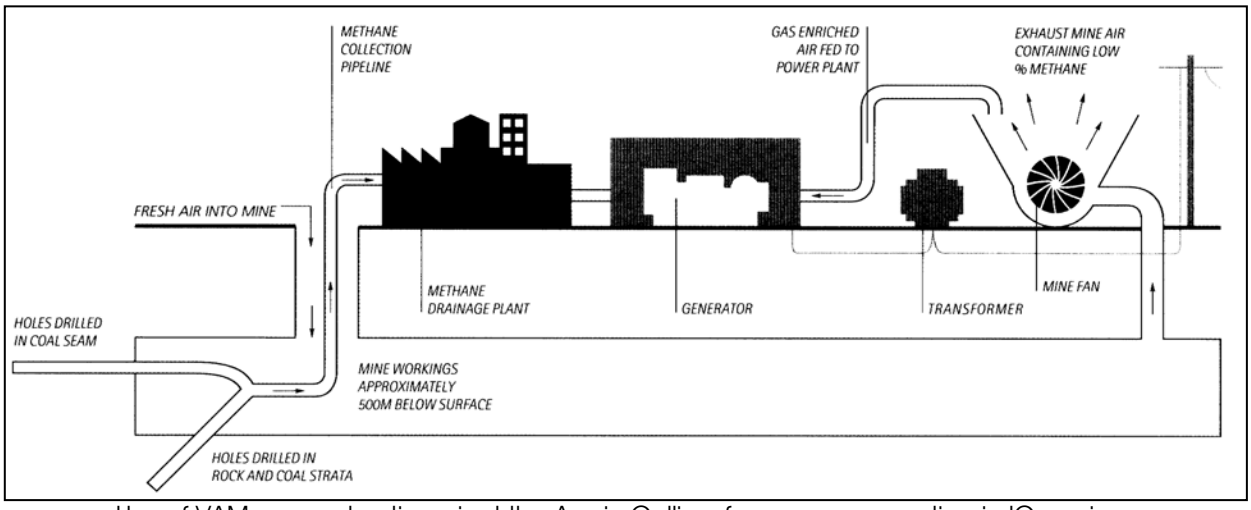
- Significantly increases overall output of internal combustion (IC) engines
- Use in IC engines is commercially proven at the Appin Power Plant, New South Wales, Australia
- Potentially economical for use in gas turbines in cases where the coal mine can supply gob gas or other low cost methane as the primary fuel
- Reduces overall emissions of methane, a potent greenhouse gas

VAM Use in Internal Combustion Engines

Mining underground coal deposits releases large quantities of methane into the mine workings, which must removed by diluting the methane with large volumes of air. Many gassy mines, like the Appin, Tower, and West Cliff Collieries in New South Wales, Australia, also drain methane by drilling boreholes into the coal seams and surrounding strata in advance of mining. The mines then pipe this methane to the surface.

In the past, the Appin, Tower and West Cliff Collieries emitted to the atmosphere most of their drained methane and all of the methane contained in the ventilation air. In 1996, Energy Developments Limited (EDL) began maximizing the use of this methane when they installed coal mine methane-powered generating plants at Appin and Tower. There are 54 internal combustion (IC) engines at Appin generating 55.6 MW, and 40 such engines at Tower generating 41.2 MW, for a total generating capacity of 97 MW. The project sells most of the resulting power to a local utility grid, and sells a portion to BHP Billiton for use at the mines.

The Appin and Tower power plants use all of the gas produced during methane drainage operations at both mines, lowering their greenhouse gas emissions. ***The Appin Colliery also uses methane from its ventilation air as feed air to the IC engines.*** This is the first project in the world to commercially use VAM. The mine uses electric vacuum pumps to route ventilation air through its upcast shaft, and then ducts it to a filtration system to remove particulates before piping it as a supplementary fuel to the generator sets.



Use of VAM as combustion air at the Appin Colliery for power generation in IC engines

Some Facts about the Use of VAM at the Appin Power Project…

- Use of methane from ventilation air as fuel increases overall plant output by 7 to 10%
- Appin can use 2,295 ft^3 (65 m^3) of ventilation air per second to produce 4-8 MW of electricity (depending on the methane content of the VAM)
- VAM supplied to the engines typically contains 0.5 to 1.0 percent methane
- Appin recovers up to 1,306 mcf (37,000 m^3) of methane per day from VAM
- The power generated is enough to power up to 60,000 homes.

VAM Use in Gas Turbines

Gas turbines, like IC engines, require air to combust fuel and produce heat. VAM can supply most or all of the combustion air required, while methane that the mine drains can supply the primary fuel. A gas turbine is a simple device that consists of an air compressor, combustors, a power turbine, and an electric generator. Gas turbines are less capital intensive than coal-fired power plants, and are available in a large range of sizes. Ideally, the mine should locate the gas turbine adjacent to the mine's ventilation exhaust shaft in order to minimize the transportation cost of the VAM.

The combustion air requirements of a gas turbine depend on its generating capacity. The combustion air required for simple cycle gas turbines is approximately 353 ft^3 (10 m^3) per hour of air per kW of installed turbine capacity, based on manufacturer operating and design data for turbines in the 1 to 100 MW size range. The more complex combined cycle plants require slightly lower air flows.

Preliminary estimates indicate that VAM containing 0.5% methane would supply 4-12% of a turbine's energy requirements, depending on operating pressures, temperatures, model selected, and other site-specific conditions. Northwest Fuel Development, Inc. demonstrated the technique in the early 1990's, using an air mixture of 0.5% to 1.5% methane in the combustion air, and proved that the turbine used less fuel than it would with ambient air as combustion air. More recently, a demonstration project operated for a short time at the Appin Mine in Australia utilizing a 2.5 MW Solar Centaur 3000R turbine, which was designed to use an inlet air flow containing about 1.6% methane. At present, EPA is further researching the potential for using coal mine methane, and VAM, in gas turbines.

Appin Turbine Installation - Side View & End View, Respectively
(Photo courtesy of DUT Pty Ltd)

Changing electricity markets, coupled with environmental concerns associated with emissions of greenhouse gases to the atmosphere, are prompting coal and electricity producers worldwide to take a new look at the methane contained in mine ventilation air. Using this VAM as combustion air for internal combustion engines and gas turbines enhances the productivity and economics of gas-fired power projects, while reducing emissions of methane to the atmosphere.

For More Information…

To obtain more information about using VAM as combustion air in gas engines at the Appin Power Project, contact:

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Or contact EPA's Coalbed Methane Outreach Program for information about this and other profitable uses for coal mine methane.

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