Alkane Energy - Applied Carbon Mitigation Technology

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ABSTRACT

Alkane Energy plc grew from an idea conceived in 1993 to capture methane from abandoned coal mines for use as fuel in a similar way to landfill gas. Alkane was founded in 1994 in Nottinghamshire, was supported by an Apax venture capital fund and floated in 2000 on the London Stock Exchange. The company has since developed containerised systems for the recovery of methane from abandoned coal mines and installed it on old mine sites as decentralised power-generation plants.

Alkane has become a leading European player in the design, construction and operation of these climate change mitigation and carbon capture plants. The company and its associate Pro2 Anlagentechnik now recover emissions of methane from abandoned and operating coal mines and other anthropogenic sources such as biogas and landfill gas for renewable electricity generation in the UK and Germany.

Keywords: Alkane, CMM, coalmine, methane, emissions

CMM AS A GREENHOUSE GAS

Growth in the world economy has resulted in increasing output of carbon dioxide, methane and other greenhouse gases, and as a consequence accelerated the rate of global warming. The second most important greenhouse gas is methane which has a global warming potential 23 times that of carbon dioxide. Methane from anaerobic decay of biomass and particularly from enteric fermentation in the stomachs of cattle and sheep accounts for around one sixth of global greenhouse gas emissions. The oil and gas industry accounts for another sixth of global methane production whilst coal mine methane (CMM) accounts for around 6%.

Unlike other anthropogenic methane sources, coal mine methane emissions are from a relatively small number of point sources at working and abandoned underground coal mines. A proportion of these emissions can therefore be captured and used for power generation and heating. The largest methane emissions occur where there is most underground coal mining with China in the lead in 2000 with (40%) followed by the USA (14%), Ukraine (7%), and Russia (7%) [1].

Worldwide CMM emissions are equivalent to around 400 million tons of carbon dioxide and this total is expected to continue to rise as more mines are opened to feed coal fired power plants in China, the US and elsewhere. Carbon capture and storage (CCS) technology may begin to reduce the rate of increase of carbon dioxide emissions but is unlikely to make a significant impact on the total within the next 10 to 15 years. The world's coal mines are expected to increase annual CMM emissions to 450 million tonnes (Mt) or about 40 billion cubic metres (BCM by 2020.

Implementation of the Kyoto Protocol, should help to reduce methane emissions from operating coal mines via the Joint Implementation (JI) and Clean Development Mechanisms (CDM) that subsidise the capture of CMM from operating mines if used in a sustainable way. Several CMM projects of this type at coal mines in China have recently been approved by the UNFCCC and the operators are earning and selling Certificates of Emissions Reduction (CERs) in the carbon markets.

CMM FROM ABANDONED COAL MINES

Abandoned coal mines also emit methane in large quantities but monitoring of these emissions is rarely undertaken and estimates are therefore difficult to make. However, the USEPA has carried out a detailed study of abandoned mines in the USA and in 2002 estimated CMM emissions from these mines to be of the order of 0.4 billion BCM. So, although a relatively small proportion of methane emissions come from abandoned coal mines there may still be enough gas to be worth capturing and using as fuel.

Underground mining operations cause fracturing of the strata above and below the worked coal seams and this widespread de-stressing results in an enormous increase in the surface area of coal from which methane can desorb. The result is that after a mine is sealed the voids become huge gas reservoirs connected to valuable gas reserves in the coal and surrounding shale and sandstone strata. Optimum conditions for exploitation of these reservoirs are where historic underground coal mining was much greater than present production. In abandoned mines there is no operational need for ventilation and the principal objective is to prevent methane from emitting to the atmosphere.

Alkane has exploited this idea and now generates around 20MW of electricity from abandoned coal mines located within its large spread of petroleum licence areas in the UK.

UK government research by DEFRA into abandoned coal mine methane emissions [2] shows that these mines

currently emit the equivalent to about 1.4 million tonnes of carbon dioxide and that emissions of this gas will continue at significant levels beyond 2050. The significance of this for the industry is not only that there are long term methane reserves for use as fuel but also that these emissions savings could be included in the revised 1990 Kyoto baseline and could ultimately be traded within the EU Emissions Trading Scheme.

For safety reasons old mine shafts tend to be sealed and fitted with vent pipes to prevent methane build up underground. As gas pressure builds up underground due to rising mine water the gas can sometimes escape at remote locations and in 1996, Arkwright Town in Derbyshire, UK had to be abandoned as methane from the nearby mine seeped into the houses and made them too dangerous for residents to continue living there. The town was demolished and the residents were relocated to a new development about a mile away.

ALKANE'S CURRENT TECHNOLOGY

As there is no ventilation in abandoned mine workings, methane purity can increase to over 70% with the remainder of the gas mixture comprising carbon dioxide and nitrogen. Alkane's early pilot projects extracted methane from the shaft top vents but when a vacuum was applied the purity dropped as air was drawn in. This problem was solved by drilling directly into the old mine roadways at depths ranging from 350 to 750 metres. The wells are cased to just above the roadway and 10 metre slotted liners used for the final section. Alkane's own design of containerised gas extraction equipment is used to test the wells and its engineers estimate the power generation capacity that could be installed from measurements of gas flow rates and methane concentrations.

Typical flow rates at Alkane's sites are up to 3,000 m^3/hour with methane concentrations as high as 72%. The gas is extracted using vacuum pumps, passed through a cyclone to remove moisture, then through several safety valves and vertical Kelburn filters to clean the gas. A slam shut valve with a failsafe closed position isolates the mine in the case of a power failure.

Alkane started its CMM developments in the 1990's with extraction and generation equipment located in large fixed buildings but these have now been replaced by containerised generation plants. The number of transportable containers and the related generation capacity of each mine site can be increased or decreased as a function of the available gas reserves. This flexibility means that plants capacity can be tailored to the optimum gas flow rate. An example of this is Mansfield-Toray (5.25MW electrical output) where the project was designed with a single well, one generation system and a short gas pipeline to supply gas to the local textile factory. As the underground gas reservoir produced at a higher rate than was initially expected, a second well was drilled and two more generators were added.

All Alkane's plants are fully automated and can be monitored and operated using a web link to a 24 hour manned control centre. The company has developed sophisticated software controls that allow remote maintenance operations and interrogation via mimics of the onsite plant control computers viewed on laptops. Alarms are set for a range of safety and engine health parameters and in the case of a breakdown that cannot be fixed remotely, technicians are called out automatically by the control system software.

Alkane has seven generating plants located in the UK's East Midlands and South Yorkshire coalfields and one in the Rhineland area of Germany. The UK coals are high-volatile, bituminous with an in situ gas content of between 4 and 6 cubic metres per tonne of coal. The sites of high economic interest were worked as underground mines and are covered by overlying strata at least 250 metres thick which reduces the risk of air influx. Following the massive retrenchment of the UK coal industry in the 1980s and 1990s there are large strategically located onshore gas reserves in more than a hundred abandoned coal mines.

Recent additions to Alkane's generating portfolio have brought the company's total energy capacity to 20MW and in 2008, Alkane's plants generated a record 90 million KWh of electricity. The plants mitigated atmospheric methane emissions equivalent to almost 600,000 tonnes of carbon dioxides offsetting atmospheric emissions from about three daily return transatlantic flights.

An independent study of Alkane's portfolio of petroleum licences by an international firm of mining consultants has identified a pipeline of more than 20 sites with the potential for over 60MW of CMM projects. They have also reported that significant coalbed methane (CBM) resources for potential future development are located within these licences.

PRO2 ANLAGENTECHNIK GMBH

Alkane's associate company in Germany, Pro2 Anlagentechnik, manufactures, operates and maintains methane capture and renewable electricity generation plants It supplies and services more than 400 containerised power generation plants in 17 countries using anthropogenic methane from coal mines, biogas plants, landfills and digesters. In the UK it supplies Alkane with containerised 1.35MW and 1.55MW power generation systems based on Deutz gas engines that use CMM as fuel.

REFERENCES

[1] USEPA Coalbed Methane Outreach Program (CMOP) website.

[2] DEFRA Report; Projected Methane Emissions from Abandoned Coal Mines in the UK; E005832\SK\Final\Dec 2005\V2.