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NEW TECHNOLOGIES FOR RECOVERY OF METHANE FROM COAL MINES

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ABSTRACT

Methane is a gas formed as part of the process of coal formation. When coal is mined, methane is released from the coal seam and the surrounding disturbed rock strata. Methane can also be released as a result of natural erosion or fault. The methane content in coal seams generally increases the deeper the seam, and also with age. As the depth of the coal seam increases, so does the pressure level. This in turn reduces the level of permeability, causing the methane to be much more tightly bound to the coal and surrounding rock strata. Underground mining can therefore produce substantially greater levels of methane than surface mining. In fact, underground mines account for the overwhelming majority (up to 90%) of all methane emissions from the coal sector. Methane is highly combustible – its release can have serious implications for the safety of mine operations. It is also a potent greenhouse gas (GHG). Tackling methane emissions is therefore an important step in meeting the challenge of climate change and in ensuring the safety of mining operations. Methane can also act as a valuable source of energy- it is the principal constituent of natural gas - allowing countries to further diversify their energy supplies. The amount of methane (CH_4) released during coal mining depends on a number of factors, the most important of which are coal rank, coal seam depth, and method of mining. Underground coal mining releases more methane than surface or open-pit mining because of the higher gas content of deeper seams. Total national emissions from Coal mining, regardless of the selected methodology, should be calculated as the sum of emissions from Underground mining, surface mining, post-mining activities, and emissions avoided due to recovery. When methane (gas) to grasping to the pillar and emission of polluted mine air to re-collect the methane content through the separators. Ventilation data from underground mines are much more accurate, typically being accurate to within 20 percent. Important considerations for completeness include emissions from abandoned mines and from waste piles, although currently no methodologies exist and data are difficult to collect. This paper focuses on the range of technologies that are available to recover methane from coal.

KEY WORDS: Coal Mining, Methane, Natural gas, Emissions, Explosion, Technologies

Introduction

Generally in mine air realizes different types of gases into atmospheric air. The air will be polluted different type of causes it is one of them. The air will create lot of damage of humans will be effected. To reduce this effected methane gas will be converted in to gasoil or liquefied oil. And also to thermal power plant to produce the electricity and house purpose. In India large 3rd coal product counters in world.

Coal will producing 222 million tones per year. The methane estimated at 556 million cubic meters. Methane has significant effect as greenhouse gas being 21times higher than that of carbon dioxide therefore it will be capture and use in gas oils has significant environmental benefits.

The mines always have naturally occurring methane associated with them to varying degrees. Like coal, methane is a hydrocarbon and is produced by the same conditions that produce coal – it forms from buried organic material that is subject to heat and pressure. However, coal is a solid formed primarily by a mixture of carbon and hydrogen atoms, with very small amounts of sulphur (bound with carbon or iron) and other elements, whereas methane naturally occurs as a gas, with each molecule made up of a single carbon atom bonded with 4 hydrogen atoms (CH_4). Methane is highly flammable and can be harvested commercially from coal seams as a fuel in its own right.

METHANE

Methane (CH_4) is a compound of carbon and hydrogen it is therefore called hydrocarbon. And it is belongs to class of hydrocarbons know as the paraffin series other members of the series of Ethan (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), pentane (C_5H_{12}) its molecular weight(16) vapor density (8) s.p gravity 0.553 relative rate of diffusion (1.34). Coal is a major source of methane gas in mines smaller amount. Actual gas content various coal seams indicate range 0-25 cubic meters pre tone. Methane has no smell. It is the main ingredient of natural gas, but the smell that consumers associate with natural gas is actually a chemical added by the gas company to make leaks obvious. Humans cannot sense methane itself, although at times it is present with another gas, hydrogen sulfide, that has an evident stink. But because the methane is often pure, miners long ago began carrying canaries to work with them, knowing that when the birds showed signs of distress it was time to get out.

The release of methane is not uniform over time; it can appear in puffs, creating a potentially explosive concentration. Some coal mine operators drill wells to pump methane out of the gob areas, or sometimes out of coal seams that they have not yet mined. They use the methane as fuel to run engines and generators to make electricity.

A range of technologies are available to recover methane from coal:

Coal Bed Methane (CBM)

Methane recovered from un-mined coal seams. The coal seams may be mined in the future but this is largely dependent upon geological factors, such as coal depth and quality.

Coal Mine Methane (CMM)

Methane recovered during mining activities as the coal is in the process of being extracted and thus emitting significant quantities of the gas.

Abandoned Mine Methane (AMM)

Methane recovered from mines that have been abandoned following the completion of mining operations. Significant amounts of methane may remain trapped in the mine or may continue to be emitted from openings.

Coal bed methane recovery process

1. Ventilation
2. Degasification
3. Superjacent method
4. Vertical gob well method

Origins of coal bed methane:

Coal seams form over millions of years by the biochemical decay and metamorphic transformation of plant materials. This coalification process produces large quantities of byproduct gases, such as methane and carbon dioxide. The amount of these Byproducts increases with the rank of coal. It is the highest for anthracite, where for every ton of coal nearly 1,900 lb of water, 2,420 lb (20,000 ft3) of carbon dioxide, and 1,186 lb (27,000 ft3) of methane are produced. Most of these gases escape to the atmosphere during the calcification process, but a small fraction is retained in the coal. The amount of gas retained in the coal depends on a number of factors, such as the rank of coal, the depth of burial, the type of rock in the immediate roof and floor, local geologic anomalies, and the tectonic pressures and temperatures prevalent at that time. The gases are contained under pressure and mainly adsorbed on the surface of the coal matrix, but a small fraction of gases is also present in the fracture net-work of the coal. Methane is the major component of gases in coal, comprising 80%–90% or more of the total gas volume. The balance is made up of ethane, propane, butane, carbon dioxide, hydrogen, oxygen, and argon.

Process:

To collect this gas trough a fire proof pipe line arrangement system. To send this pipe line separate bore hole shaft on to the surface. In surface the gas will convert in three stages in to oil .

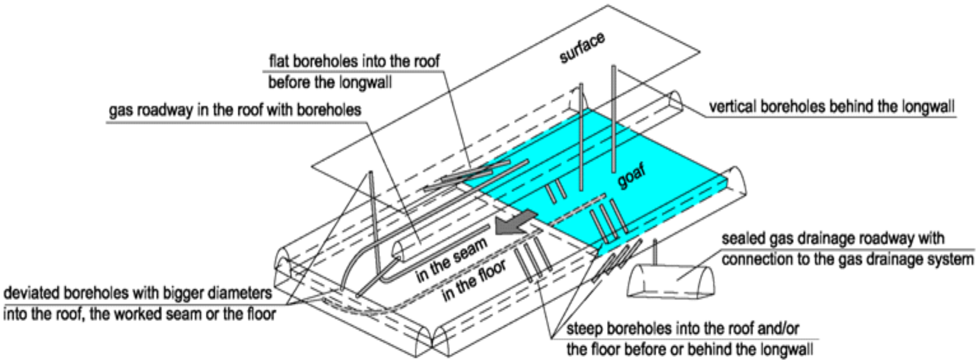

Fig showing drainage pipe line through the gob area

Fischer - Tropsch

The Fischer–Tropsch process starts with partial oxidation of methane (natural gas) to carbon dioxide, carbon monoxide, hydrogen gas and water. The ratio of carbon monoxide to hydrogen is adjusted using the water gas shift reaction, while the excess carbon dioxides removed with aqueous solutions of alkanol amines (or physical solvents). Removing the water yields synthesis gas (syngas) which is chemically reacted over an iron or cobalt catalyst to produce liquid hydrocarbons and other byproducts. Oxygen is provided from a cryogenic air separation unit.

Methane to methanol process

Methanol is made from methane (natural gas) in a series of three reactions:

Steam reforming

$CH_4 + H_2O \rightarrow CO + 3\ H_2$ $\Delta H = +206\ \text{kJ mol}{-1}$

Water shift reaction

$CO + H_2O \rightarrow CO_2 + H_2$ $\Delta H = -41\ \text{kJ mol}{-1}$

Synthesis

$2\ H_2 + CO \rightarrow CH_3OH$ $\Delta H = -92\ \text{kJ mol}{-1}$

The methanol thus formed may be converted to gasoline by the Mobil Process.

Methanol to gasoline process (MTG)

In the early 1970s, Mobil developed an alternative procedure in which natural gas is converted to syngas, and then methanol. The methanol polymerized over a zeolite catalyst to form alkenes.

First methanol is dehydrated to give dim ethyl ether:

$$2\ CH_3OH \rightarrow CH_3OCH_3 + H_2O$$

This is then further dehydrated over a zeolite catalyst such as ZSM-5, which would theoretically yield ethylene:

$$CH_3OCH_3 \rightarrow C_2H_4 + H_2O$$

But which in practice is polymerized and hydrogenated to give a gasoline with hydrocarbons of five or more carbon atoms making up 80% of the fuel by weight. Syngas to gasoline plus process (STG+)

The STG+ Process:

A third gas-to-liquids process builds on the MTG technology by converting natural gas-derived syngas directly into drop-in gasoline and jet fuel via a thermo chemical single-loop. The STG+ process follows four principal steps in one continuous process loop. This process consists of four fixed bed reactors in series in which synapses converted to synthetic fuels. The steps for producing high-octane synthetic gasoline

1. Methanol Synthesis:

Syngas is fed to Reactor 1, the first of four reactors, which converts most of the syngas (CO and H_2) to methanol (CH_3OH) when passing through the catalyst bed.

2. Diethyl Ether (DME) Synthesis:

The methanol-rich gas from Reactor 1 is next fed to Reactor 2, the second STG+ reactor. The methanol is exposed to a catalyst and much of it is converted to DME, which involves dehydration from methanol to form DME (CH_3OCH_3).

3. Gasoline synthesis:

The Reactor 2 product gas is next fed to Reactor 3, the third reactor containing the catalyst for conversion of DME to hydrocarbons including paraffin's (alkenes), aromatics, naphthenic (cycloalkanes) and small amounts of olefins (alkenes), mostly from C6 (number of carbon atoms in the hydrocarbon molecule) to C10.

4. Gasoline Treatment:

The fourth reactor provides trans alkylation and hydrogenation treatment to the products coming from Reactor 3. The treatment reduces durance (tetra methylbenzene)/isobutene and trimethyl benzene components that have high freezing points and must be minimized in gasoline. As a result, the synthetic gasoline product has high octane and desirable isometric properties.

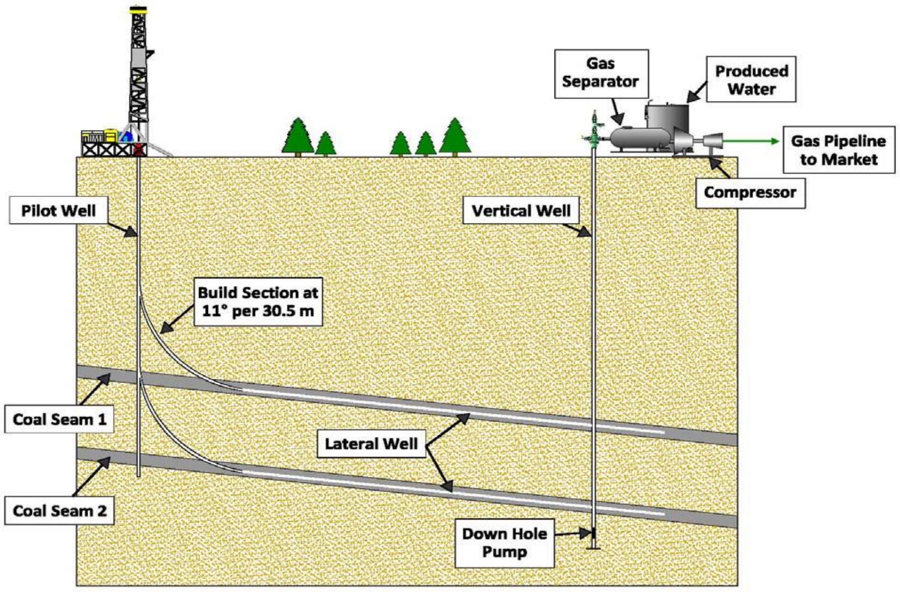

Fig showing the inner diagram of coal bed methane recovery and drainage line

5. Separator:

Finally, the mixture from Reactor 4 is condensed to obtain gasoline. The non-condensed gas and gasoline are separated in a conventional condenser/separator. Most of the non-condensed gas from the product separator becomes recycled gas and is sent back to the feed stream to Reactor 1, leaving the synthetic gasoline product composed of paraffin's, aromatics and naphthenic.

Conclusion:

Methane is ubiquitous on the coal mines. Often, the deeper the mine, the more pressure released in mining and the more methane freed. The release of methane is not uniform over time; it can appear in puffs, creating a potentially explosive concentration. The present paper discussed about the prospect of clean energy source and the enhanced recovery techniques of Methane from coal mines. To meet the rapidly increasing demand for energy and faster depletion of conventional energy resources, India with other countries is madly searching for alternate resources like coal bed methane (CBM), shale gas, gas hydrate. CBM is considered to be the most viable resource of these. When humans discovered rocks that could provide warmth and fuel cooking fires, coal was likely viewed as a gift from the gods. Extracting coal bed methane (CBM) from underground coal seams may not have the same significance to modern man, but this source for natural gas. Certainly seems like a gift to a world in need of clean energy supplies. Because today's oil and gas industry recognizes the value of this unconventional resource, CBM exploration and development, once uniquely are now under way on a global scale.

References:

1. Shale Gas and Coal-bed Methane (unconventional gas) September 2012
2. See Canadian Society for Unconventional Gas Web site for more details on these gases: http://www.csug.ca 2 Enviroline. 2002. Volume 13, No.19–20, Energy Issues, p. 8.
3. National Energy Board. 2002. Short-term Natural Gas Deliverability from the Western Canada Sedimentary Basin 2002–2004, p. v.; http://www.neb.gc.ca/energy/ema_stngd_wcsb-2002_2004_e.pdf. The Western. Sedimentary Basin includes the gas-producing regions in the Foothill zone in BC, east of the Rockies, Alberta and Western Saskatchewan. Total production of conventional natural gas in this region is expected to decline from 470 million cubic metres per day (m3 /d) (16.6 billion cubic feet per day (Bcf/d)) in 2001 to 450 million m3 /d (15.9 Bcf/d) by the end of 2004.
4. EnCana Corporation. 2002. EnCana Cash Flow Tops $1 Billion in Third Quarter. News release, November 5; http://www.encana.com/news_and_views/4_0_20021105_1.shtml; Canada NewsWire. 2002. Quicksilver Resources Announces Commercial Coal Bed Methane Development. News release. October 17. Quicksilver Resources Inc. is the parent company of MGV Energy Inc., operating in Alberta; http://www.newswire.ca/releases/October2002/17/c2034.html

5. ALL. 2002. Handbook on Best Management Practices and Mitigation Strategies for Coal Bed Methane in the Montana Portion of the Powder River Basin. Prepared for: U.S. Department of Energy, National Petroleum Technology Office, National Energy Technology Laboratory. Tulsa, OK. EPA-HQ-OW-2008-0517, DCN 05254.

6. ALL. 2003. Handbook on Coal Bed Methane Produced Water: Management and Beneficial Use Alternatives. Prepared For: Ground Water Protection Research. (July). Available online at: http://www.allllc.com/CBM/pdf/CBMBU/CBM%20BU%20Screen.pdf. EPA-HQ-OW-2004-0032- 2483, DCN 03451.

7. ALL. 2006a. A Guide to Practical Management of Produced Water from Onshore Oil and Gas Operations in the United States (October). EPA-HQ-OW-2008-0517, DCN 10000.

8. ALL. 2006b. Siting, Design, Construction, and Reclamation Guidebook for CBNG Impoundments. Prepared for: U.S. Department of Energy, National Petroleum Technology Office. EPA-HQ-OW-2008-0517, DCN 05399.