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The Overview of Indonesia's Coal Bed Methane Resources

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Abstract

Coal layers generate Coal Bed Methane (CBM), and there is a preceding process: coal formation (coalification). Coalification begins with the burial of organic material originating from plants. The burial, lasting hundreds of millions of years, increases temperatures and pressures, causing physical and chemical changes to the organic material. Methane gas, the most significant component of CBM, is formed. Two processes: biogenic and thermogenic. In the early stages of coalification, biogenic methane gas is produced as a byproduct of the activities of decomposing microorganisms (anaerobic bacteria), similar to what occurs in the decomposition of organic waste. Only about 5 to 20 percent is stored within coal. There are four mechanisms for gas storage in coal: absorption, adsorption, free gas, and gas dissolved in water. Among these four mechanisms, adsorption is the most significant, accounting for 98% of the stored CBM in a combined system of micropores (coal matrix) and cleats. Coal Bed Methane resources in Indonesia can be found across South Kalimantan, East Kalimantan, Sumatra, and Java.

Keywords: Coal Bed Methane, Coalification, Biogenic and Thermogenic, Coal Matrix and Cleat, Resources of Indonesia Coal Bed Methane.

Introduction

Coalbed methane (CBM) represents an unconventional energy resource with substantial untapped potential, although its development has historically been limited. It is the country's most viable supplementary energy source (Song Y. et al., 2012).

The demand for energy is increasing alongside the growth of the global population. Oil and natural gas (fossil fuels) are non-renewable energy sources, as they originate from the remains of ancient organisms that died millions of years ago. A coal bed should be considered a specific gas collector with different properties from oil and gas collectors (Andrzej, 2017). Fossil fuel reserves are depleting due to continuous exploitation, while discoveries are insignificant.

Recently, methane gas found in coal beds (called CBM or coal bed methane) has been considered an alternative energy source to conventional gas (see Figures 1 and 2). Many oil companies are beginning to explore this type of gas, and the Indonesian government has even opened up CBM mining concessions through a tender system. Every tender participant must submit a technical report and economic calculations.

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Predicting the methane gas content in coal has become a crucial factor in this context. The coal bed structure plays an essential role in the preservation, accumulation and enrichment of CBM (Tang Ying et al., 2018) (Adreas & Yves, 2011). Besides that, the parameters of proximate and Ultimate Analysis were correlated with the gas content of coal (Harinandan et al., 2015).

Literature Review

1. Coalification and Coal

Coal consists of over 50% by weight and 70% by volume of carbon compounds, including non-reducible moisture (1). Coal is a non-clastic sedimentary rock. Non-clastic sedimentary rocks are defined as sedimentary rocks formed by chemical, biological, or biogeochemical processes on the Earth's surface without undergoing erosion and deposition processes like clastic sedimentary rocks, followed by burial and compaction,

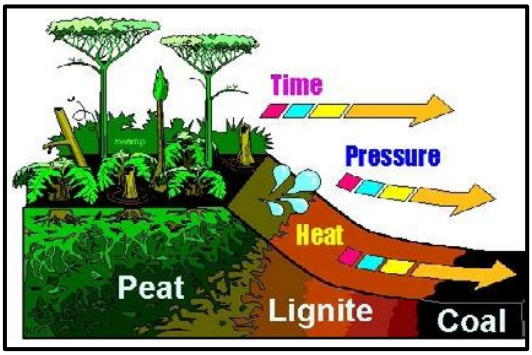

Figure 1. Genesis of coal (Flores, 2014)

Which is further continued through coalification. Coalification transforms organic material into a different organic material influenced by environmental conditions. CBM is generated during coalification and stored within coal on internal surfaces. This gas can be generated by microbial processes (Reem, 2012).

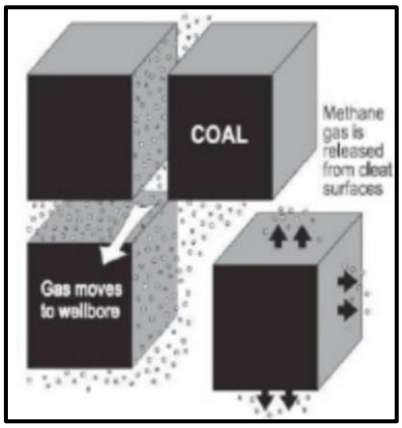

Figure 2. Methane gas in coal (Andrew, 1987)

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2. Coal Bed Methane

Coal Bed Methane (CBM) resources refer to the methane gas in coal bed layers. Coal Bed Methane (CBM) is natural gas in coal seams (Bruce & Doruk, 2023) (Sugata & Saurabh, 2021). This methane gas is trapped within coal pores and can be extracted for use as an alternative energy source.

The extraction of methane gas from coal beds has significant economic potential and can help reduce greenhouse gas emissions when used as a substitute for other fossil fuels. Developing coal bed methane resources requires advanced and sustainable extraction techniques to ensure efficient and environmentally friendly exploitation.

Methane resources in coal bed layers can be crucial to a country's energy portfolio and provide economic, energy, and environmental benefits when managed wisely (Bruce Mutumu, 2023).

3. Indonesian Coal Bed Methane Resources

Indonesia has significant coal bed methane (CBM) resources. CBM, also known as coal seam gas (CSG), is natural gas stored in coal seams. Indonesia's CBM resources are found in various coal basins across the country. Some of the key CBM resource areas in Indonesia include:

South Sumatra Basin is one of Indonesia's most prominent CBM-producing regions. It is home to extensive coal deposits that contain significant amounts of CBM.

Central Kalimantan: The Central Kalimantan region also has substantial CBM potential, with coal seams that can be a source of natural gas.

East Kalimantan: Another promising area for CBM resources, East Kalimantan has coal seams that can be exploited for natural gas.

Barito Basin: Located in Central Kalimantan, the Barito Basin has coal deposits with CBM potential.

The exploration and development of CBM resources in Indonesia have gained attention due to the country's growing energy needs and the desire to diversify its energy sources. CBM is considered a cleaner energy source than conventional fossil fuels like coal and can contribute to Indonesia's energy security.

Efforts are ongoing to explore and extract CBM in these resource-rich areas, with several companies and government initiatives involved in developing this valuable energy resource. The Indonesian government has been promoting policies encouraging CBM exploration and production, aiming to utilise this indigenous resource for domestic consumption and potential export.

Research and Discussion

Coalification is the process of coal formation through accumulating and transforming plant remains and other organic materials over millions of years. This

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process involves various stages, and coal is one of the vital fossil natural resources. Some of the main stages in coal formation include:

Accumulation of Organic Material: The process begins with accumulating organic remains, such as plant debris, in specific carbon-rich environments. This typically occurs in swamp or lake environments with organic sediments.

Maturity is a crucial factor affecting gas- generating ability and adsorptive capacity. Coals with different maturities exhibit different pore features, permeabilities and gas-bearing characteristics, and their genetic types and accumulation processes may also differ (Tang Ying et al., 2018).

Pressure and Heat Transformation: Over time, these organic layers become buried under layers of new sediment, and pressure and heat increase. This results in the drying and transformation of organic material into lignite, sub-bituminous coal, bituminous coal, and anthracite (based on the degree of metamorphism).

Coal Formation: This process takes place over millions of years and results in coal with higher carbon content and lower moisture levels. Coal rank generally shows a positive correlation with the CBM generation and content (Qian Wang et al., 2020).

Coal is a vital fossil energy source widely used for generating electricity, heating fuel, and as a raw material in industry (Rohit et al., 2023). However, the use of coal also has significant environmental impacts, including issues related to greenhouse gas emissions and air pollution. Therefore, society and governments are increasingly focusing on cleaner and more sustainable energy sources as alternatives to reduce the negative impacts of coal usage.

The origins of coal bed methane and the two primary categories of its formation: biogenic and thermogenic. Let me explain these concepts:

Biogenic Coal Bed Methane:

Biogenic methane is formed through biological processes. In the case of coal bed methane, this type of gas is typically generated by microorganisms that consume organic matter in coal seams (Rita Susilawati, 2015).

Microbes break down organic material in coal, such as plant remains, and produce methane as a metabolic by-product.

Biogenic methane is usually found in shallower coal seams and tends to have a different isotopic signature than thermogenic methane.

Thermogenic Coal Bed Methane:

Thermogenic methane is created through the thermal degradation of organic material. In the case of coal bed methane, this process is often associated with the burial and heating of coal over time.

As coal becomes buried and subjected to high temperatures and pressures, its organic matter undergoes chemical changes, generating methane. Thermogenic methane is typically found in more profound, mature coal seams and often has a Different isotopic composition than biogenic methane.

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Understanding the origin of coal bed methane is essential for exploration and production because it can influence the quality and quantity of methane extracted from coal deposits. Biogenic and thermogenic methane sources may have different geological and chemical characteristics. This knowledge is essential for the effective development of coal bed methane resources.

Indonesia's coal bed methane (CBM) resources are significant and distributed across various regions (Acquah et al., 2019). CBM is an important alternative energy source that can be harnessed to meet domestic energy needs. Some characteristics of CBM distribution in Indonesia include:

East Kalimantan: This region is one of Indonesia's major areas with significant CBM resources. Several basins, such as Kutai Timur and Tarakan, have substantial CBM potential.

South Kalimantan: This region also holds considerable CBM resources, particularly in the Barito basin.

Sumatra: Several areas, such as around the Muara Enim and Tanjung Enim basins, also have substantial CBM potential.

Java: There are some CBM prospects around Java, especially in the eastern part of the island.

The Indonesian government has taken steps to develop the CBM potential in the country. 2019, the Indonesian Ministry of Energy and Mineral Resources issued Regulation No. 14 of 2019 on the Management of Geothermal and Coal Bed Methane Business, which regulates CBM exploitation.

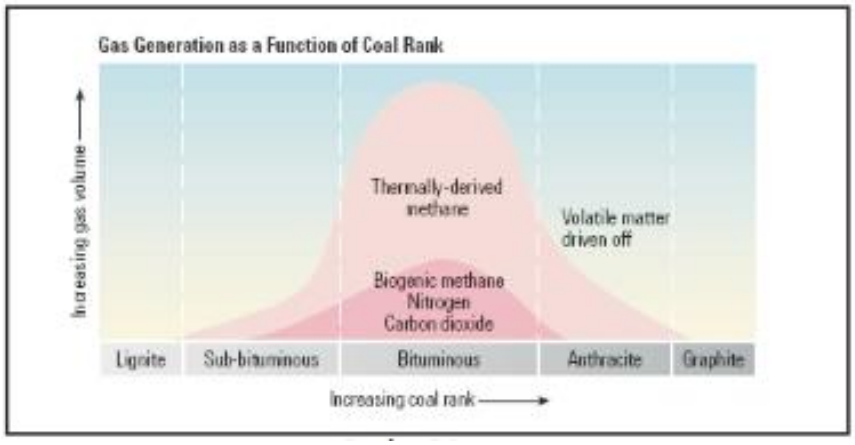

Figure 1: The relationship of gas volume formed as a function of coal rank (Anderson, 2023)

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Figure 2: Resources of Indonesia Coal Bed Methane
(Acquah et al., 2019)

Conclusion

1. Coal is classified as a non-clastic sedimentary rock that forms via chemical, biological, or biogeochemical processes, as opposed to the deposition of solid particles.
2. Biogenic methane arises from biological processes, particularly coal bed methane where microorganisms commonly generate gas by consuming organic matter within coal seams. Thermogenic methane, conversely, results from the heat-induced breakdown of organic substances. In the case of coal bed methane, this occurrence is often associated with the gradual burial and subsequent heating of coal.
3. Indonesia's coal bed methane reserves are across South Kalimantan, East Kalimantan, Sumatra, and Java.

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