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The effect of coal petrology on the capacity of gas methane absorption in coal formation Tanjung Barito in Binuang Region, South Kalimantan

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Abstract. Tanjung Formation is an Eocene - Oligocene coal carrier formation. This formation is stratigraphically situated above the bedrock of Pratersier age. The location of this formation is in Binuang area, South Kalimantan approximately 20 km northwest of Banjarbaru city. The method of research by taking the coal sampling from the bottom seam to the top. Laboratory analysis is done in the form of coal petrography analysis and adsorption test. Coal seam of Tanjung Formation is found with thickness 50 to 600 cm. Megascopy, this coal seam is black, bright (bright-bright banded), black scratch, concoidal shards, and lightweight. Results of developing meceral analysis were vitrinite 22. 6% - 46.4%, inertinite 0.6% - 19.4%. and liptinite 0.4%, mineral matter 0.4% - 0.6%. Based on the reflectance reflection of vitrine (Rv) shows the range between 0.53 - 0.58. The rank of the entire coal is subbituminous B, based on the ASTM classification. Based on the analysis of gas adsorption shows from the lower coal seam to upper with the range 412.94 – 675.27 SCF / Ton. The upper coal seam of the small gas adsorption while at the bottom of coal seam is large gas adsorption. This change in gas adsorption is caused because the lower coal seam contains pyrite minerals, while the top is rarely found in pyrite minerals. The size of pyrite mineral content will affect the adsorption of methane gas.

Keywords: maceral, adsorption, vitrinite reflectant.

1. Introduction

Coal methane gas is formed during the process of biofuel through a biogenic process with the help of micorganism or through a thermogenic process with the help of temperature. Methane gas comes from kerogen type III which has a lower hydrogen-carbon ratio and a greater oxygen-carbon ratio. Type III kerogen is dominated by maceral vitrinite to produce gas and has a large gas absorption capability [1]. The absorption of coal methane gas is the process of attaching a gas molecule that is in the liquid phase on a solid surface through chemical or physical bonds with the amount of gas> 95% [2]. Methane gas is trapped and absorbed in coal through cleats and matrices. Methane gas is not the only gas contained in coal, but this gas can reach 90 -95% of the total gas available. Various types of coal have different gas absorption rates [3]. While the storage capacity of methane gas is related to the

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volume of methane gas (gas content), if the absorption is greater then the volume of gas will increase. Gas absorption is influenced by inherent physical properties and geological environmental factors, the influence of physical properties include: rank, ash content, pore structure, moisture content, coal lithotype, composition of maceral, coal facies [4]. Geological environmental factors: temperature, pressure, grain and degree of deformation [5].

One of the availability of coal in Indonesia is in the Barito Basin [6 and 7]. There are 3 (three) coal carrier formations, namely Eocene-Oligocene Tanjung Formation with coal thickness between 0.5 - 4 meters. Middle Miocene Warukin Formation with coal thickness of 50 cm to 40 meters, based on the presence of coal this formation is divided into Warukin Formation Upper, Middle, and Lower. Dahor Formation is Upper Mioaen-Pliocene with coal thickness of 25 cm - 6 meters.

Coal methane absorption is not only affected by the rank of coal (rank), but determined by the composition of the maceral. The pore system that can absorb CO2 and CH4 gas is very poreous coal which is inertinite while vitrinite is less poreous [8]. Differences in vitrinite, liptin and inertinit content will affect gas uptake [8]. Methane gas absorption is also influenced by the quality of coal and depth, the increasing depth, the lower the ash content, volatile matter and moisture, while the fixed carbon content is higher. Conditions of increasing depth can affect the value of coal methane absorption capacity increasing [9].

2. Method

2.1 Study area

The location of the study was in the village of Arang Alus, Binuang District, South Hulu Sungai Regency, South Kalimantan Province. The research company, PT Tanjung Alam, is approximately 50 km northwest of Banjarbaru city.

Figure 1. The location of research area to element tectonics of Barito Basin [11].

2.2 Coal Layer of Tanjung Formation

The coal carrier formation in the Tanjung Formation represents the type of coal deposited during the Paleogene syn-rift phase in the Barito Basin. These coal deposits are associated with the fluviatile environment to lacustrine, the layer is lenticular or thinned laterally [11]. The coal seam in the lower Tanjung Formation was deposited during the transgression phase during the Paleogene post-rifting deposition. The coal layer of the Eocene Tanjung Formation is characterized by high rank volatile bituminous coal, with a thickness ranging from 0.5 - 6 meters, the coal layer rises above the sandstones and fluvial siltstone and is covered by siltstone brackish water to shallow seas, mudstone and tidal sandstones of sulfur layer the coal rises from the bottom up.

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2.3 Sampling

Coal sampling in the PT Tanjung Alam open pit located in the southeast of Binuang sub-district is approximately 15 km southeast of the Binuang sub-district city. There are 4 seams, including seam A with a thickness of 0.5 m above, then underneath seam B with a thickness of 3 meters and splitting towards the south, then underneath again seam C with a thickness of 6 meters, and the bottom seam D with a thickness of 1.5 meters thinning towards the south that rises above the base conglomerate. (figure 2).

The sampling method is carried out by channel sampling method from two seams namely seam B and Seam C. Megascopically, this coal layer is black, bright - bright banded, black scratch, concoidal, and light. Seamless coal B contains a lot of pyrite minerals, coal seam C does not contain pyrite minerals.

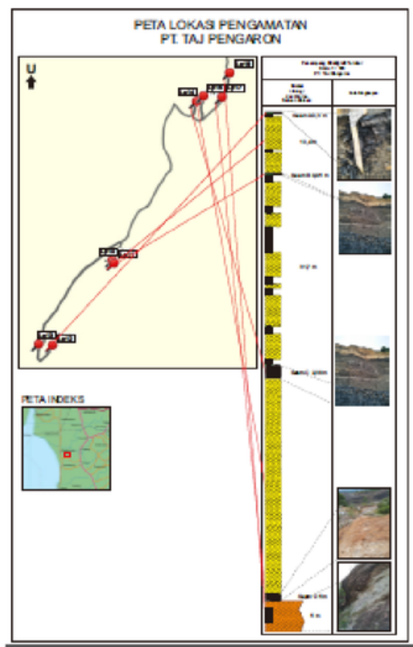

Figure 2. Coal seam profile from seam A to D.

There are two (2) coal samples from the Tanjung Formation coal in Binuang district, South Kalimantan. Sampling is done by channel sampling method. Samples were taken in seam B and C, seam B consisting of top and bottom seam. Seam C samples are taken at the bottom, middle and top.

Proximate analysis was carried out with the LECO Model TGA 701 tool, the results of the analysis included ash content, moisture content, levels of flying substances, fixed carbon, bulk density. Proximate analysis using reference Australian Strandard ASTM D 7582.

Coal petrogragraphy analysis by doing coal samples were then crushed to a maximum size of 1 mm and placed in resin blocks. The sample blocks were polished with a specified polisher. Microscopic investigation was carried out with a Carl-Zeiss Axio Imager.A2m reflected-light microscope. During maceral analysis, 500 points with a minimum distance of 0.2 mm between each point were counted from the polished sections. The maceral composition is stated as percent (% volume). Maceral classification used in this study refers to Australian Standard AS2856 (1986).

The work of maceral analysis in the laboratory includes:

Microscopic analysis of coal to identify the composition of maceral, mineral and vitrinite reflectant values. Conto coal taken by drill core and then prepared for polishing incision. In the sample preparation required some tools and materials such as:

Coal samples

1. Resin powder (transoptic powder)
2. Crusher
3. Size size 16, 20, and 65 mesh
4. Mold polished briquette, heater, thermometer, and press
5. Polishing tools (grinder-polisher)
6. Silicon carbide size 800 and 1000 mesh and alumina oxide size 0.3; 0.05; and 0.01 microns
7. Glass preparations and candles.

The coal sample obtained from the outcrop is reduced by coning and quartering to obtain the appropriate number of samples for analysis needs. Furthermore, the coal samples were crushed manually and sieved by using a mesh size of 16 mesh and 20 mesh, the grain size of 16-mesh coal +16 mesh obtained was used for coal petrography analysis.

Coal fraction size -16 mesh +20 mesh is then mixed with resin powder (transoptic powder) with a ratio of 1: 1. The mixture is further inserted into the mold and heated to 200 ° C. After the temperature reaches 200°C the heater is turned off and the mold is pressurized to 2000 psi. Briquette can be removed after the temperature reaches room temperature. The next stage is briquette polishing that begins with cutting using a polishing tool (grinder-polisher) then smoothed with silicon carbide size 800 mesh and 1000 mesh above the glass surface. Further polished by using alumina oxide size 0.3 micron, 0.05 micron, and last size 0.01 micron above silk cloth or silk cloth. The resulting polishing incision is placed on a glass plate with an evening candlestick and then leveled.

Observation of polished incision is done by using reflectant microscope both qualitatively and quantitatively to determine the mineral and mineral content in coal.

Microscopic research using reflected rays with 200 times magnification with 500 points of observation.

The analysis process was conducted at Petrography Coal Laboratory, Puslitbang TEKMIRA, Bandung. Coal Minerals Classification uses Australian standard (US 2856, 1986) and the microscope used is Microscope Spectrophotometer Polarization with Fluorescence, type: MPM 100, brand: Zeiss.

Methane adsorption gas analysis is done by grinding coal coal to 60 mesh. The sample is then inserted into the pressure transmister tube and then flowed with methane gas. Changes in pressure are carried out until the standard pressure, then each change in pressure is observed to change in volume. The amount of gas absorption is calculated using the Languir formula. The tool used to measure the amount of gas absorption is coal bed methane isotherms. Langmuir formula V = Vl x (P/P + Pl) where

V = volume of adsorption gas. scf/ton
Vl = Langmuir volume constant, scf/ton
P = Pressure , Psi
Pl = Pressure where gas storage capacity.

3. Result

Based on coal petrography analysis are summarized the coal quality and petrography of the Tanjung Formation. Coal in Tanjung formation has the following qualities: table 1.

Table 1. List of coal quality

No	ID sampel	Depth (meter)	Inh. Moisture (% wt. Adb)	Ash content (% wt. Adb)	Volatile matter (% wt. Adb)	Fixed carbon (% wt. Adb)	Volatile (% wt. dmmf)	Bulk Density (gr/cc)	Keterangan
3	PIT 1 Seam B	1516.900	4.330	1.995	45.475	48.200	48.546	1.270	Sub bituminous B
4	PIT 2 Seam C	1529.500	2.910	1.350	45.175	50.565	47.185	1.264	Sub bituminous B

While the coal quality parameters include moiiture, ash content, volatile matter, bulk density is higher than that of C seam. The difference in coal quality will cause differences in the ability to absorb methane gas.

Coal petrography Formation Tanjung seam B is composed of maceral : the telovitinite sub-maceral is composed of maceral telovitrinite = 22.6%, the detrovitrinite sub-maceral is composed of maceral desmocolinite = 45.4%, maceral liptinite composed of maceral resinite = 0.4%, maceral inertinite: sub maceral teloinertinite composed of fusinite maceral = 0.6%, semifusinite = 8.4%, sclerotinite, 18.6%; the geolovitrinite sub-maceral is composed of 3.4% maceral macrinite, and mineral matter in the form of pyrite=0.6%(figure3).

The composition of maceral seam C composed of telovitrinite sub maceral arranged by maceral telovitrinite = 46.6%, detrovitrinite sub maceral composed by maceral desmocolinite = 29.4%, maceral inertinite: sub maceral telo inertinite composed by maseal semifusinite = 4.0%, sclerotinite = 19.4%; sub maceral geloiniernite composed of maceral macrinite = 0.4%, and mineral matter composed of pyrite = 0.4%. (figure 3).

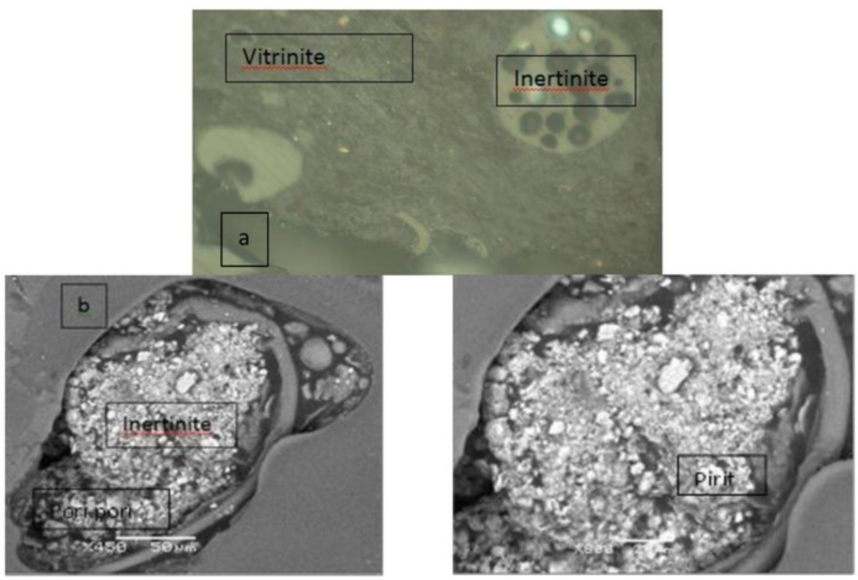

Figure 3. (a) Coal petrography maceral vitrinite and inertinite, (b) scanning image from SEM with 450 x magnification sample A, (b) scanning image from SEM with 800 x magnification sample B.

The composition of maceral seam C composed of telovitrinite sub-maceral composed of telovitrinite maceral = 46.6%, detrovitrinite sub maceral composed of maceral desmocolinite = 29.4%, maceral inertinite: sub maceral telo inertinite composed by mash semifusinite = 4.0%, sclerotinite = 19.4%; sub maceral geloiniernite is composed of maceral macrinite = 0.4%, and mineral matter is composed of pyrite = 0.4%. (figure 4).

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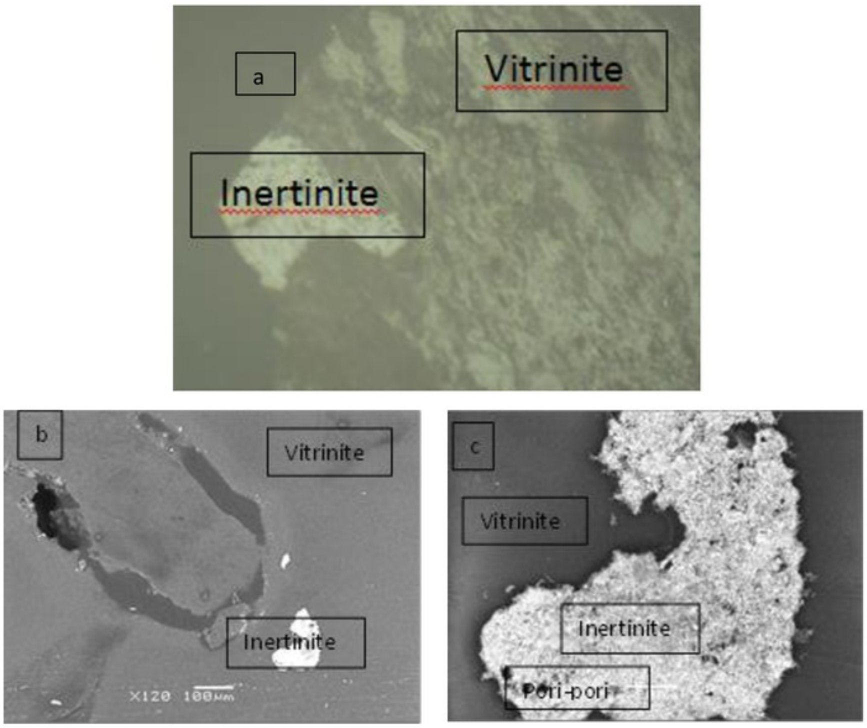

Figure 4. (a) Coal petrography maceral vitrinite and inertinite, (b) scanning image from SEM with 120 x magnification sample A, (b) scanning image from SEM with 800 x magnification sample B.

The results of the analysis of gas absorption using the sample under As Received (ar) and dry ash free (daf) conditions. The absorption of coal methane gas is carried out at *Lembaga Minyak dan Gas (Lemigas),* the result of gas adsorption analysis on seam B in the DAF coal condition of 430.45 scf / ton, in the As Receive coal condition of 412.94 scf / ton. (Figure 5)

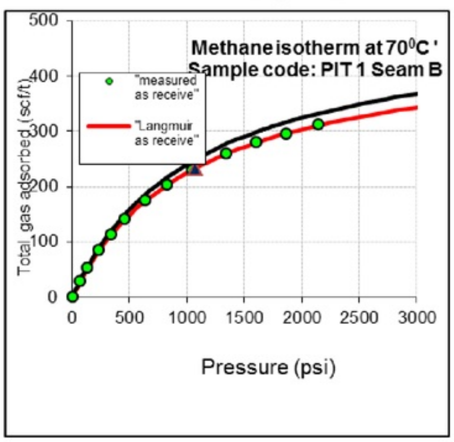

Figure 5. Sorption ishoterm CH_4 in coal sample seam B from Tanjung Formation

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Coal methane absorption is carried out at *lembaga Minyak dan Gas (Lemigas)*, the results of gas adsorption analysis on seam C at DAF coal condition of 672.76 scf / ton, on As Receive coal condition of 672.67 scf / ton. (Figure 6).

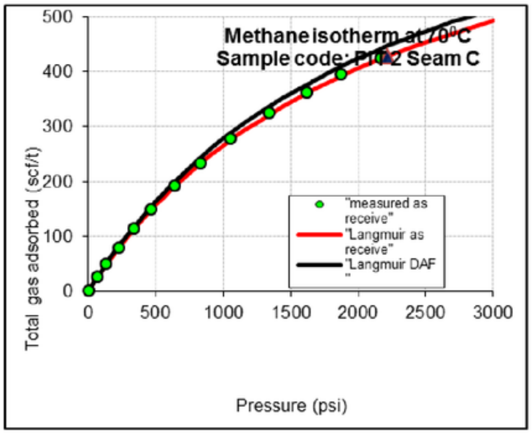

Figure 6. Sorption ishoterm CH_4 in coal sample seam C from Tanjung Formation

4. Discussion

The paper discusses the absorption capacity of gases related to coal composition and coal quality. Maceral differences will have different absorption capacities and produce different amounts of gas. Maceral vitrinite produces more gas during the coal formation process than inert maceral. Inertinite-rich coal has a high gas absorption capacity than vitrinite-rich coal [12]. The average gas absorption in inertinite is faster than in vitrinite [13]. The process of gas absorption is influenced by pressure, when the formation of coal with low pressure, the volume of absorbed gas is related to the macerum vitrinite, but at high pressure the volume of absorbed gas is related to the inertinite maceral [14].

Seam B coal has a 68% maceral vitrinite content, 31% inertinite, coal seam D has a 75% maceral vitrinite content, inertinite 23.8%. The difference in the maceral content of the two samples caused a difference in the absorption of different gases. The amount of methane gas absorption in seam B is 412.94 Scf / ton, in seam C the amount of methane gas absorption is 675.27 Scf / ton. The distance between the seam B and C is very small, which is about 20 meters. This seam B coal rich in inertinite will cause higher gas absorption because the pore pore in inertinite is more than the coal seam C layer which is less inert. Reduced absorption of methane gas in the seam due to inertinite in the seam B is a lot of mineral content in the form of pyrite (figure 3). The content of mineral elements increases causing the absorption of methane gas to decrease [15]. In seam coal B contains a lot of pyrite (figure 3), where the pyrite mineral element is in the pore pores in the inertinite maceral, the presence of pyrite in the pore pores causes methane gas to be absorbed will be disrupted by the presence of pyrite minerals. In Figure 3 it can be seen clearly that the pyrite minerals found in the vitrinite are very small and the size is very small. Coal seam C in figure 4 shows that without the presence of pyrite minerals in both vitrinite and inertinite, the process of methane gas absorption is very good. The difference of micro pore between seam B and seam C where seam B is micro size is relatively larger than the size of micro pore in seam C. The number of micro pores on C seam is relatively more compared to the number of micro pores on seam B. Difference in micro pore size and the amount causes a difference in the absorption capacity of coal methane gas, micro pores with small pores and more in number will absorb more pores, while large micro pores and small amounts will reduce the absorption capacity of methane gas.

The ash and volatile matter content is large in seam B (table 1) compared to ash and volatile matter in seam C. coal layer. Low ash content and high volatile matter will cause small gas absorption. The high ash content and the small amount of volatile matter will increase the absorption of methane gas.

5. Conclusion

Two samples of seam B and Seam C have high methane gas applications with sub bituminious coal ratings b.
Maceral content, especially vitinite and inertinite, affect the absorption of methane gas.
Ash content, volatile matter and mineral content of the mineral to the absorption of methane gas.
Micro pores filled with pyrite mineral content will reduce the absorption of methane gas.

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