The Variation of Hardgrove Index and Coal Microscopics Characteristics of Coal Bitahan, Rantau, South Kalimantan, Indonesia

by Basuki Rahmad

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Greetings from Cooperative International Network for Earth Science and Technology (CINEST)

We are facing with global environmental problems with problems on resources depletion at behind. In particular, the rapid increases in mineral resources and energy consumptions have cast a shadow over the sustainability of human activities. The CINEST was founded in 2008 to enhance cooperative studies and activities by young researchers and engineers, because their boldly tackles must be keys and absolute foundation to solve problems found on the earth, especially in Asia and Africa. I would like to emphasize to young researchers that performing research "by hand" rather than "by manual" may develop their potential to find new solutions.

This international symposium started from 2008 cooperating with The JSPS International Training Program during 2008 to 2012, and has been supported by Mitsui-Matsushima Co., Ltd. from 2013. The important objective of the symposium is strong networking of young researchers to enhance international collaboration to solve both of global and domestic problems on mineral resource and environment.

Finally, I would like to sincerely thank all of the organizations and participants, and believe the symposium will provide fruitful successes for all.

Welcome to "International Symposium on Earth Science and Engineering 2018."

K Sasaki

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Saturday, 1st of December, Field Trip "Museum of Underground Gold Mine and Old Castle Town in Oita"

(Registration is still opened)

8:50 Meet at the meeting place, JR Hakata Station (Chikushi ext.)

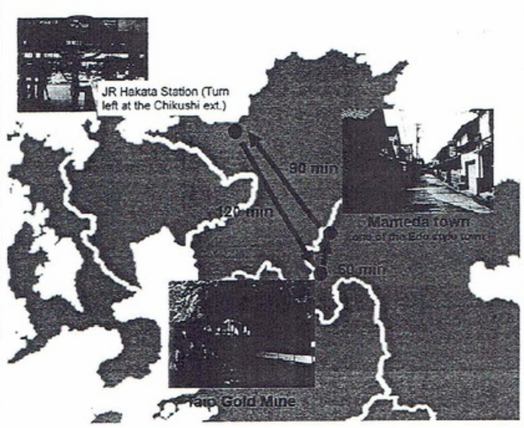
9:00 Depart from JR Hakata Station by bus (One brief stop on the way)

11:00 - 12:00 **Taio Gold Mine, Oita Pref. (underground tour, and panning of placer gold,** Hita city, Oita pref.)

12:00 - 13:00 **Lunch in Taio Gold Mine Restaurant** (Hita city, Oita pref.) *1,000 yen for lunch box.

14:00 - 15:00 **Mameda town** (**one of the Edo style town,** Hita city, Oita pref.) (One brief stop on the way back)

16:30 Arrived at JR Hakata station



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Pisith Mao
Tumelo K.M Dintwe
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Albano Mahecha
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Rachmat Sule
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*"MITSUI MATSUSHIMA AWARD" will be given to Best Papers, Best Presentations and Best Posters at the Awards Ceremony

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The Variation of Hardgrove Index and Coal Microscopics Characteristics of Coal Bitahan, Rantau, South, Kalimantan, Indonesia

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ABSTRACT

Hardgrove Index is the measure of the amount of energy needed to grind (grindability) a coal. If coal is too hard, then the Hardgrove Index value is low, so it requires more power for the mill. In general the range of HGI values between 30 - 120. However, users for steam coal many that set the value of Hardgrove Index about 50 or above 45. Commonly the value of Hardgrove Index is controlled by mineral matter and organic petrography (microscopic / maceral characteristics).

Rantau Coal especially Seam-A has a thickness of 15 meters. Hardgrove Index values vary between 41-82, Calorivic Value between 5605 - 5222 cal / gr (adb), Ash content between 11.4 - 2.13% (adb), Fixed Carbon content of 39.23 - 37.89% (adb). The microscopic composition Seam-A consists of vitrinite between 74-80.2 (vol.%), liptinite 1.2-2.4% Vol., inertinite 22.8-15.8% Vol., mineral matter 1.4 -2.4% vol. The average vitrinite reflectance is 0.45%, including the Sub-bituminous rank. Factors that influence the value of Hardgrove Index include: microscopic (maceral) and Mineral Matter compositions. Minerals oxide class (ash) and inertinite maseral is the hardest mineral it will decrease the Hardgrove Index, while clay minerals and sulfates are the softest so it will raise the value of Hardgrove Index. Coal hardness is a function of rank, mineral matter and microscopic characteristics of coal (maceral).

***Keywords**: hardgrove, grindability, rank, mineral matter, maceral, mill.*

INTRODUCTION

Indonesia is one of the largest coal producing countries in the world, it's just that coal in general has almost the same characteristics of maceral composition (inertinite content is about 5% (vol.), Vitrinite 87.95% (vol.), Liptinite 7.42% (vol.) and sclerotinite as part of inertinite ranges from 2.1% (vol.). This is due to the coal-forming material (plant) and the relatively similar (tropical) deposition conditions parameters even though it lies wide in the area Indonesia with diverse geological conditions (Daulay, 1994; Nas, 1994; Anggayana, 1996; Amijaya, 2005; and Widodo, 2008).

This research will discuss Hard Grove Index (HGI) and the characteristics of microscopic.

HGI, is one of the physical properties of coal which states the ease of coal to be pulverized to 200 mesh or 75 micron.

HGI is very important for coal users in power plants that use pulverized coal. HGI cannot be used as an indication or performance simulation of a pulverizer or milling directly, because the performance milling is still affected by the operational conditions of the Milling itself, such as Mill tention, Temperature primary air, classifier settings and others. However, HGI can be used as a comparison for coal with each other regarding the ease of being milled.

The value of HGI from a coal, one of which is determined by mineral matter (ash) and organic coal such as the type of maceral (Suarez-Ruiz and Crelling, 2008). In general, the higher the coal rank (subbituminus), the lower the HGI.

The Hardgrove Grindability Index is a measure of coal grindability.

The microscopic characteristics of coal-forming organic components (maceral) are vitrinite, liptinite, and inertinite and changes in coal maturity based on Reflectant Vitrinite (Rv) to determine the rank of thick coal in Warukin Formation. One parameter to determine the composition of coal microscopy is from the aspect of coal type which relates to coal-forming plant species and in its development will be influenced by biochemical processes during the peat process and the potential of coal methane gas resources in Bitahan, Rantau, Tapin Regency, South Kalimantan (Figure 1)

Figure 1. Research area of Tectonic Regional Elements (Ott, 1978)

In coal microscopy consists of various organic components (maseral). The formation of macerals from plant remains during the initial stages of peat accumulation depends on the type of plant community, climate, and ecological control and depositional environmental conditions (Stach et al., 1982). Maseral coal is divided into 3 vitrinite, liptinite and inertinite maseral groups based on reflectance values, presence of cellular structure, gelification level, and morphological appearance. The three maseral groups differ in their chemical composition and physical properties (as well as their optical properties).

SAMPLE AND METHODS

There are some samples taken from Seam-A of coal in the area Bitahan, Rantau, South Kalimantan, Indonesia (Figure 2). Sampling is done by cannel sampling, sample in dry in sun on aerial dry, crushed ,and before a blender is done the analysis. Proksimat and Hardgrove Index (HGI) analysis was performed on 5 samples of coal, analysed using the procedure according to the standard ASTM (1991). Analyzed in the laboratory of Tekmira Bandung Indonesia. Chemical analysis proksimat results Moisture, volatile, and ash, calories. Coal petrographic Analysis conducted with the Microscopic analysis of coal to identify the composition of maseral, minerals and reflektan value of vitrinite. Microscopic studies using x-ray reflection by 200 times magnification observation with as much as 500 points. Classification of Coal Maceral used of America standards 2856 (USA, 1986) and a microscope that is used is the *Fluorescence Polarization Microscope Spectrophotometer with*, type: MPM 100, brand: Zeiss.

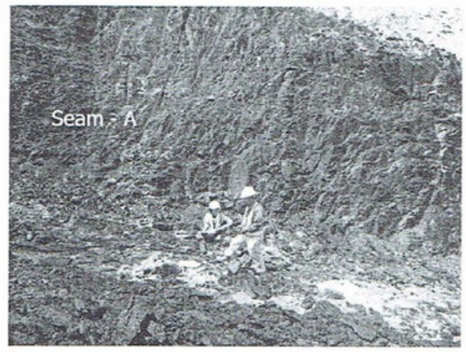

Figure 2. Coal sampling of Seam-A

RESULT

Hardgrove Index values vary between 41-82, Calorivic Value between 5605 - 5222 cal / gr (adb), Ash content between 11.4 - 2.13% (adb), Fixed Carbon content of 39.23 - 37.89% (adb). The microscopic composition Seam-A consists of vitrinite between 84.34-90.12 (vol.%), liptinite 2.11-2.56% Vol., inertinite 5.21-10.43% Vol., mineral matter 1.64 -3.12% vol. The average vitrinite reflectance is 0.43%, including the rank of coal are Sub-bituminous (Low Rank Coal)

Table 1. Coal Proximate and HGI Analysis Result

No	Total Moisture % (ar)	Moisture %(Adb)	Ash %(Adb)	Volatile Matter %(Adb)	Fixed Carbon %(adb)	Total Sulphur %(Adb)	CV adb	HGI
1(Top)	35.84	18.63	2.13	41.35	37.89	0.09	5222	82
2	35	20.65	2.44	40.46	36.45	0.13	5240	80
3	35.91	18.5	2.99	41.57	36.94	0.14	5221	47
4	35.26	12.96	7.3	42.29	37.45	0.06	5353	50
5	36.83	20.36	4.05	40.39	35.2	0.12	5080	51
6	35.88	11.4	4.55	44.82	39.23	0.08	5605	41
7(Bottom)	37.65	21.09	3.22	40.8	34.89	0.07	5061	52

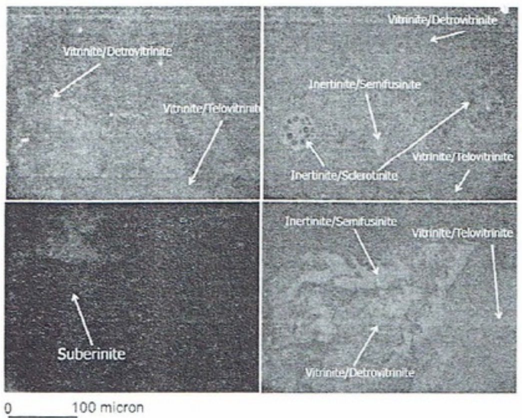

Figure 3. Coal Microscopic of Seam-A

Table 2. Composition of Coal Microscopics Seam-A

Number Sample	Vitrinite % (Vol.)	Liptinite % (Vol.)	Inertinite % (Vol.)	Mineral Matter % (Vol.)	Reflektan Vitrinite (Rv) %	HGI
1 (Top)	84.34	2.11	10.43	3.12	0.49	82
2	86.54	2.32	7.91	3.23	0.48	80
3	88.65	2.43	6.50	2.42	0.39	47
4	88.66	2.21	6.58	2.54	0.43	50
5	87.67	2.43	7.44	2.46	0.44	51
6	90.12	2.56	5.68	1.64	0.35	41
7 (Bottom)	89.78	2.44	5.21	2.57	0.44	52

DISCUSSION

Grindability of coal is a function of coal hardness, strength, tenacity, and inherent fracture, which are linked (again) to coal rank, coal type and grade. Coal is commonly pulverized prior to utilization to increase its surface area and reactivity in a given, whether combustion or metallurgical coke making. Because size reduction is related to energy and smaller particles require greater energies to achieve a given size, say, for combustion requires greater mill power and therefore greater costs. Because reactivity is related to maceral composition as well as particle size, coal rich in reactive macerals, for example, vitrinite or liptinite, may not have to be ground to the same finenessas coalswith less reactive inertinite macerals and mineral matter. Abundant mineral matter will increase abrasion and wear in the milling process as well as reduce its efficiency. Increase moisture content also reduce coal grindability for coal of a given rank (Suarez-Ruiz and Crelling, 2008).

The hardgorve grindability test is commonly used to characterize the milling behaviour of coals. The test, first conceived by hardgrove and later modified to the current constant-weight test in 1951, attempts to mimic the operation of a continuous coal pulverized using a batch process. As noted by hardgrove and others, the test is empirical and has limitations, but it is widely used and even included as a specification in contract for the supply of coal (Suarez-Ruiz and Crelling, 2008).

In the hardgrove grindability test, 50 g of a limited particle size range (16x30 mesh, or 1,18 mm x 600 m) of coal is ground in a ball mill for 60 revolutions. The resulting coal is sized and the weight of the (<200 mesh) product is recorded and by calibration to a reference coal, used in the calculation of the hardgrove grindability index (HGI). The test result in a value for HGI generally between 30 and 100. The lower the HGI number, the harder it is to grind the coal. The test is highly nonlinear such that a change in HGI from 90 to 80 result in a small decrease in mill capacity, whereas a change from 50 to 40 leads to a considerably greater decrease in mill capacity (Suarez-Ruiz and Crelling, 2008).

The preparation of the 50 g quantity of 1.18 mm x 600 m (16 x 30 mesh) coal from the larger original size, introduces a bias into the test. A number of studies have demonstrated that the elimination of the <600 m (-30 mesh) fraction from the test material creates a sample differing in petrographic composition from the original sample due to the partitioning of brittle vitrinite-rich and (unmineralized) inertinite rich microlithotype into the fine fraction, the fraction not tested. This is less likely to be a problem in the analysis of single-lithotype samples, particularly lithotype dominated by either bright (vitrain, very bright clarain) or dull (durain) litologies. Coal delivered to utilities are not single lithotypes, however, so the bias in the test is a problem (Suarez-Ruiz and Crelling, 2008).

On the petrographic scale, HGI is a function of the rank, maceral composition, and mineral content of a test coal. The most fundamental overall relationship is the peak of HGI in the medium to low volatile bituminous rank range. The actual rank at which this peak occurs will vary based on the data used, and the large scatter in the data, particularly in the peak range, is most probably due to differences in composition. The lower energy breakage results greater scatter among vitrain-rich coal lithotypes in the range compared to the more massive dull coal. Low-rank and high-rank coals can both have low

HGI numbers, although for very different reasons (Suarez-Ruiz and Crelling, 2008).

The explained that a strong correlation between an increase in liptinite content and decrease HGI (harder to grind) for coals of narrow vitrinite reflektance ranges for a suite of Carboniferous age coals. Indeed, they noted a 39 HGI difference between a vitrinite-rich lithotype and a durain within the same, iso-rank seam section, indicative of the maceral/micolithotype versus HGI relationship (Suarez-Ruiz and Crelling, 2008).

For any liptinite content in their sample set, HGI increased with an increase in rank within the high volatile bituminous rank range investigated. They suggested that liptinite from high volatile bituminous coal is resistant to breakage while vitrinite, fusnite, and semifusinite tend to be brittle. The relationship between an increased consentration of liptinite-rich microlithoype and a decrease in HGI for some place coals from narrow vitrinite reflectance ranges. For example, for 66 coals in the 0.85-0.90 % Rmax range, they found that liptinite, durite, duroclarite, and clarodurite all decreased HGI. For coals with inherently low liptinite content, the general rule of thumb that duller or finer grained or nonbanded lithotype will be harder to grind than more well-banded lithotype can be applied (Suarez-Ruiz and Crelling, 2008).

Working with Eocene age coals from Indonesia , Moore et.al (1990) demonstrated a direct relationship between HGI and megascopic coal lithotypes and it particular the texture and proportion of vitrain bands in hand spicemens and phyterals in polished blocks. The link between megascopic coal type and HGI or any other breakage behavior allows the trend to be tracked through coal seam mappingin combination with bore cores. Just as there are regional difference s in coal composition and rank between coals of differenceages and basins, there will be differences in the grindability linked to a coal's rank, texture, and composition (Suarez-Ruiz and Crelling, 2008).

Mineral and moisture content will also have an impact on coal grindability. Minerals into four groups based on their grinding behavior: clays and sulfates, quartz, oxides, and silicates,pyrites and other sulfides, and carbonates. Quartz and other nonclay silicates and oxides tend to be the hardest minerals and clays and sulfates are the softest minerals. Shales can have a wide range of grindability but generally are softer than the associated coal. Intercalated shale with coal will tend to lower the HGI and intergrown carbonates, as found in some Permian Gondwana coals, tend to decrease HGI (Suarez-Ruiz and Crelling, 2008).

CONCLUSION

- Hardgrove Index (HGI) is a function of the coal rank and maceral composition
- There are a strong correlation between an increase in liptinite content and decrease Hardgrove Index (HGI)

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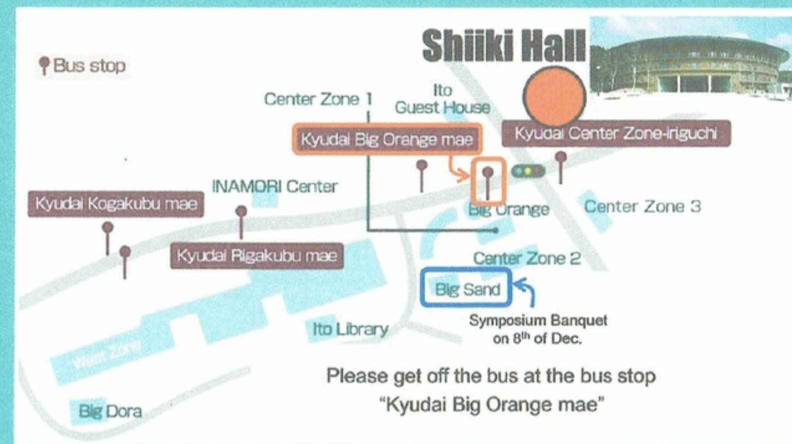

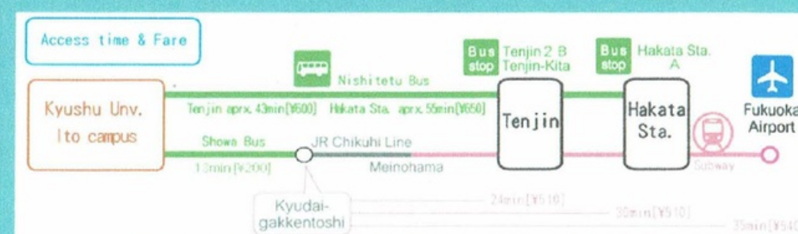

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