Journal of Innovative and Creativity
Journal Homepage: https://joecy.org/index.php/joecy
e-mail: journaljoecy@gmail.com

Faculty of Education
University of Pahlawan Tuanku Tambusai
ISSN 2775-771X (Online)
ISSN 2962-570X **(Printed)**
5 (1) 2025, Page: 25830-25836

Classification of Coal Quality Based on Proximate Analysis at CV. Bara Mitra Kencana to Meet the Requirements of Ombilin Power Plant

Ahmad Fadhly[1], Jevie Carter Putra[2] Rudy Anarta [2], Trisna Prima Sari S[2]

[1]Geological Engineering, Universitas Negeri Padang, Padang 25131, Indonesia
[2]Mining Engineering, Sekolah Tinggi Teknologi Industri Padang, Padang 25131, Indonesia

[a)] Corresponding author: ahmadfadhly@unp.ac.id

Published: April , 2025

ABSTRACT

Coal quality and classification was essential, as coal served as an alternative energy resource for industry. Prior to utilization, coal quality and classification were analyzed through laboratory testing. One method that was applied was the proximate analysis based on ASTM D388 standards. This study used coal samples collected from three coordinate points at CV. Bara Mitra Kencana. The test results indicated variations in coal quality. Coal from this location was utilized as fuel for the Ombilin Steam Power Plant (PLTU), with a blending process carried out beforehand to improve the economic value of lower-quality coal. The coal quality received by PLTU Ombilin was recorded at 17.00%, with a significant improvement observed after blending. Based on laboratory analysis, the coal was classified as bituminous—high volatile A, which was generally caking in nature. The calorific value obtained was 14,316 Btu/lb for sample I, and 14,062 Btu/lb for samples II and III. These results demonstrated that the calorific value of coal from CV. Bara Mitra Kencana exceeded 14,000 Btu/lb, thereby meeting the quality standards required for power plant operations.

Keywords: Coal Quality, Blending Effectivity, Stockpile, Bituminous High Volatile A, ASTM D388

INTRODUCTION

Increasing of global energy consumption has resulted in higher coal production [1]. CV Bara Mitra Kencana is one of the coal mining companies located in Tanah Kuning, Batu Tanjung Village, Talawi District, Sawahlunto City, West Sumatra Province. The mining system applied by the company is an open-pit method (surface mining). The assessment of coal quality is an essential aspect of coal processing, as coal quality data strongly determine its potential utilization and play a crucial role in anticipating consumer demand [2].

Changes in coal quality may be influenced by several factors, including the geological conditions of the mining area, coal excavation and transportation activities, as well as coal stockpiling processes [3]. The coal produced by CV. Bara Mitra Kencana is primarily used as fuel for the Ombilin Steam Power Plant (PLTU), which requires a maximum ash content threshold of 17.00%. One of the standard methods for determining coal quality is proximate analysis based on ASTM standards.

A study at PT. Pelabuhan Universal Sumatera, Muaro Jambi Regency, revealed that the calorific value of coal at the stockpile was 5,411.90 Kcal/Kg, while the coal loaded on barges recorded 5,397.75 Kcal/Kg. The ash content was 3.09% at the stockpile and 3.27% on barges. The main factors affecting variations in coal quality included contamination, particle size degradation, and testing bias due to improper sampling methods that did not comply with SNI

standards [3].

Furthermore, research by on coal quality determination in Enrekang Regency, based on proximate and ultimate analyses, indicated significant variations [4]. Laboratory results from two sampling sites classified Enre 1 coal as very low grade coal, while Enre 2 coal was categorized as high grade coal. These quality differences were interpreted as being influenced by variations in the peat-forming conditions of the respective deposits.

REGIONAL GEOLOGY

The concession area of CV. Bara Mitra Kencana covers approximately 49.61 hectares, within which various supporting facilities have been developed to ensure smooth operational activities. These include enclosed facilities such as offices and workshops, as well as open areas such as mine access roads, overburden disposal areas, and settling ponds. Exploration activities identified that the coal resource reserves within the ±49.61-hectare concession reached 1,194,168 tons. The layout of CV. Bara Mitra Kencana's concession area is presented in Figure 1.

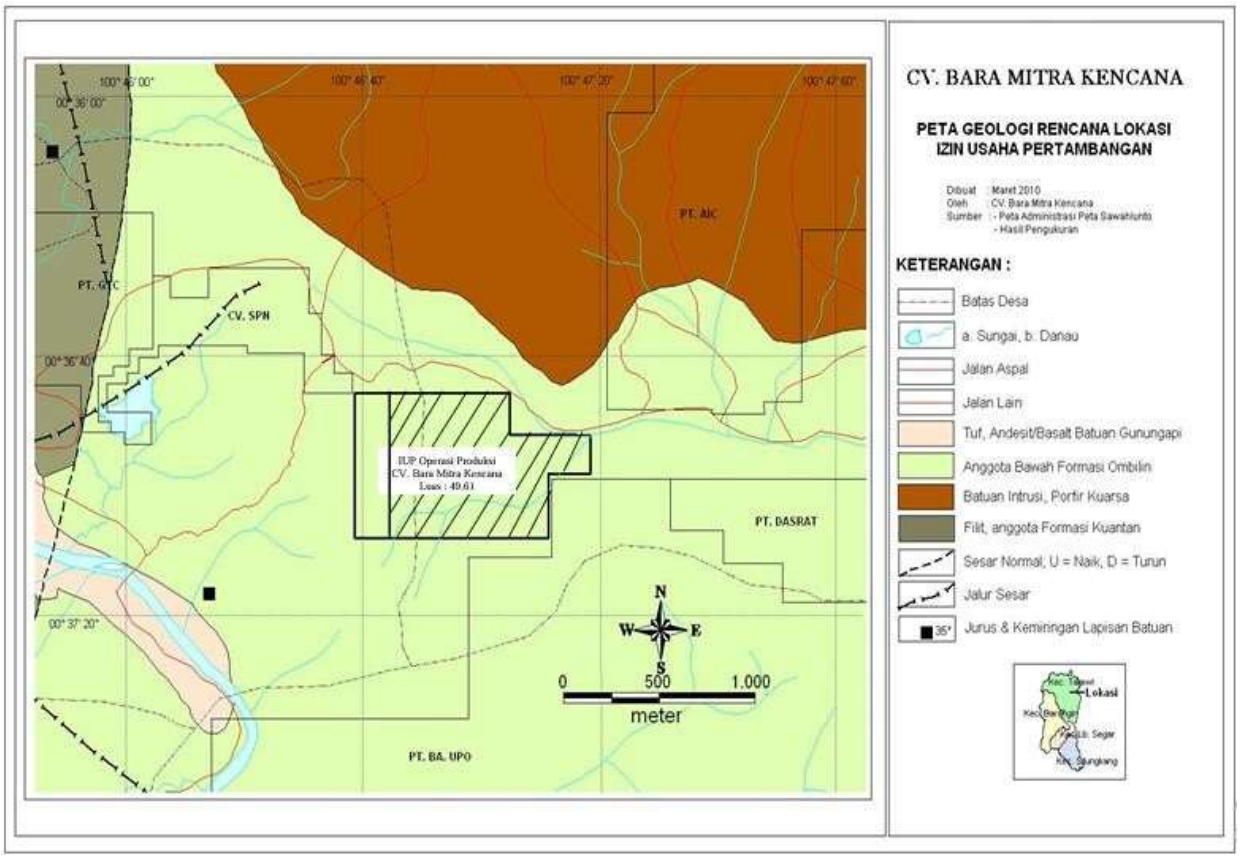

FIGURE 1. (a) Geological Map of the Ombilin Basin; (b) Stratigraphy of Ombilin Basin [2]

The geological classification of an area requires consideration of several factors, namely tectonic aspects or the influence of lateral forces, sedimentation aspects since coal is a sedimentary deposit, and variations in coal quality related to the economic viability of the resource. Among these three aspects, the most dominant factor in the study area becomes the basis for classifying the geological conditions according to their complexity. The geological classification for the Talawi area is presented in Table 1.

Table 1. Geological Condition in Research Area

No	Parameter	Kondisi Geolog		
		Simple	**Moderate**	**Complex**
1.	Fault	Don't Have Fault	Rare	Dense
2.	Fold	Almost not Folded	Moderately Folded	Strongly Folded
3.	Intrusion	Not Influence	Influence	Very Influence
4.	Slope	Gentle	Moderate	Steep
II	**Sedimentation Aspect**			
1.	Thickness Variaton	X < 10 %	10 % < x < 50 %	X > 50 %
2.	Conformity	Thousands Metres	Hundreds Metres	Tens Metre
3.	Parting	Don't Have Parting	Some Parting	Much Parting
III	**Variation of Quality**	**Less Variaton**	**Medium Variation**	**Complex Variation**

METHODOLOGY

This research was conducted on a laboratory scale using a quantitative approach. The analysis of coal quality was carried out using the proximate method, and the classification was determined based on ASTM D388 standards. The testing parameters included Inherent Moisture, Ash Content, Volatile Matter, and Calorific Value. Sample testing was performed at the PT. Geoservices Laboratory in Padang. The coal samples were collected from CV. Bara Mitra Kencana, located in Tanah Kuning, Batu Tanjung Village, Talawi District, Sawahlunto City, West Sumatra Province.

RESULT

ASTM Result on Seam I

Table 2. Data Analysis of ASTM in Seam I

Parameter	Unit	Entry	Adb	Db	Arb (SFA)	dmmfb	mmmfb
Equibrilium Moisture	%	3.94	-		3.94		
Inheret Moisture	%	3.22	3.22	3.22			
Ash Content	%	5.72	5.72	5.91	5.66		
Volatile Matter	%	39.80	39.80	39.80	39.50	43.26	
Fixed Carbon	%	-	51.26	51.26	50.90	56.74	
Total Sulphure	%	0.88		0.83	0.82		
Gross Calorific Value	kcal/kg	7519	7510	-	7454		7953
	btu/lb				13417		14316
	mj/kg						33.30
SO3		0.25	-	0.25			
Classification	Bituminous Coal – High Volatile A – Commonly Agglomerating						

Based on Table 2, the first sampling point (Seam I) at the coordinates (100°46'51.60"E) and (00°37'02.10"S) showed varying parameter values. The Inherent Moisture (IM) content on an air-dried basis (adb) was 3.22%. The Ash Content was 5.72% (adb), 5.91% (dry basis, db), and 5.66% (as-received basis, arb). The Volatile Matter (VM) content was 39.80% (adb), 41.12% (db), 39.50% (arb), and 43.26% (dried mineral matter-free basis, dmmf). The Total Sulfur (TS) content was 0.83% (adb) and 0.82% (arb). The Calorific Value (CV) recorded 7,510 kcal/kg (adb), 7,454 kcal/kg (arb), and 13,417 Btu/lb, while on a moisture and mineral matter-free basis (mmmfb), it reached 7,953 kcal/kg, 14,316 Btu/lb, and 33.30 MJ/kg.

Table 3. Blending Result in Seam I

Lot	Name of Sample	Total Moisture % (ar)	Moisture % (adb)	Ash % (adb)	Volatile Matter % (adb)	Fixed Carbon % (adb)	Total Sulphur % (adb)	Calorific Value Cal/g (adb)	Cal/g (ar)	Cal/g (daf)
1	SIM 1	5.11	3.22	5.72	39.8	51.26	0.83	7510	7363	8247
3X		10.18	7.34	19.78	35.39	37.49	0.85	5788	5611	7942
Cummulative		9.17	6.52	16.97	36.27	40.24	0.85	6132	5959	8015

Based on Table 3, the coal quality data after the blending process can be observed. For Seam I, the blending results show that the **Total Moisture** is 9.17%, **Inherent Moisture** 6.52%, **Ash Content** 16.97%, **Volatile Matter** 36.27%, **Fixed Carbon** 40.24%, and **Total Sulphur** 0.85%. The calorific value is **6,132 cal/g (adb)**, **5,959 cal/g (ar)**, and **8,015 cal/g (daf)**.

ASTM Result on Seam II

Table 4. Data Analysis of ASTM in Seam II

Parameter	Unit	Entry	Adb	Db	Arb (SFA)	dmmfb	mmmfb
Equibrilium Moisture	%	5.96	-	-	5.96	-	-
Inheret Moisture	%	2.72	2.72	-	-	-	-
Ash Content	%	2.58	2.58	2.65	2.48	-	-
Volatile Matter	%	42.34	42.34	43.52	40.93	44.51	-
Fixed Carbon	%	-	52.36	53.83	50.63	55.49	-
Total Sulphure	%	0.46	0.46	-	0.44	-	-
Gross Calorific Value	kcal/kg	7858	7858	-	7596	-	7812
	btu/lb				13673		14062
	mj/kg						32.71
SO3		0.46	-	0.46	-	-	-
Classification		Bituminous Coal – High Volatile A – Commonly Agglomerating					

Based on Table 4, the second sampling point (Seam II) at the coordinates (100°47'03.60"E) and (00°37'00.00"S) showed varying parameter values. The Inherent Moisture (IM) content on an air-dried basis (adb) was 2.72%. The Ash Content was 2.58% (adb), 2.65% (dry basis, db), and 2.48% (as-received basis, arb). The Volatile Matter (VM) content was 42.34% (adb), 43.52% (db), 40.93% (arb), and 44.51% (dried mineral matter-free basis, dmmf). The Total Sulfur (TS) content was 0.46% (adb) and 0.44% (arb). The Calorific Value (CV) was 7,858 kcal/kg (adb), 7,596 kcal/kg (arb), and 13,673 Btu/lb, while on a moisture and mineral matter-free basis (mmmfb) it reached 7,812 kcal/kg, 14,062 Btu/lb, and 32.71 MJ/kg.

Table 5. Blending Result in Seam II

Lot	Name of Sample	Total Moisture % (ar)	Moisture % (adb)	Ash % (adb)	Volatile Matter % (adb)	Fixed Carbon % (adb)	Total Sulphur % (adb)	Calorific Value Cal/g (adb)	Cal/g (ar)	Cal/g (daf)
1	SIM 2	4.91	2.72	2.58	42.34	52.36	0.46	7858	7681	8298
3 X		10.18	7.34	19.78	35.39	37.49	0.85	5788	5611	7942
Cummulative		9.13	6.42	16.34	36.78	40.46	0.77	6202	6022	8029

Based on Table 5, the coal quality data after the blending process for Seam II are as follows: Total Moisture 9.13%, Inherent Moisture 7.34%, Ash Content 16.34%, Volatile Matter 36.78%, Fixed Carbon 40.46%, Total Sulphur 0.85%, with calorific values of 6202 cal/g (adb), 6022 cal/g (ar), and 8029 cal/g (daf).

ASTM Result on Seam III

Table 6. Data Analysis of ASTM in Seam III

Parameter	Unit	Entry	Adb	Db	Arb (SFA)	dmmfb	mmmfb
Equibrilium Moisture	%	3.68	-	-	3.68	-	-
Inheret Moisture	%	3.16	3.16	-	-	-	-
Ash Content	%	1.03	1.03	1.06	1.01	-	-
Volatile Matter	%	42.36	42.36	43.74	42.13	44.07	-
Fixed Carbon	%	-	53.45	55.20	53.18	55.93	-
Total Sulphure	%	0.5	0.5	-	0.5	-	-
Gross Calorific Value	kcal/kg	7881	7881	-	7389	-	7812
	btu/lb				14110		14062
	mj/kg						32.71
SO3		0.46	-	0.46	-	-	-
Classification		Bituminous Coal – High Volatile A – Commonly Agglomerating					

Based on Table 6, the third sampling point (Seam III) at the coordinates (100°46'55.10"E) and (00°36'59.20"S) showed varying parameter values. The Inherent Moisture (IM) content on an air-dried basis (adb) was 3.16%. The Ash Content was 1.03% (adb), 1.06% (dry basis, db), and 1.01% (as-received basis, arb). The Volatile Matter (VM) content was 42.36% (adb), 42.74% (db), 42.13% (arb), and 44.07% (dried mineral matter-free basis, dmmf). The Total Sulfur (TS) content was 0.50% (adb) and 0.50% (arb). The Calorific Value (CV) was 7,881 kcal/kg (adb), 7,389 kcal/kg (arb), and 14,110 Btu/lb, while on a moisture and mineral matter-free basis (mmmfb) it reached 7,812 kcal/kg, 14,062 Btu/lb, and 32.71 MJ/kg.

Table 7. Blending Result in Seam II

Lot	Name of Sample	Total Moisture % (ar)	Moisture % (adb)	Ash % (adb)	Volatile Matter % (adb)	Fixed Carbon % (adb)	Total Sulphure % (adb)	Calorific Value Cal/g (adb)	Cal/g (ar)	Cal/g (daf)
1	SIM 2	4.91	3.16	1.03	42.36	53.45	0.5	7881	7796	8226
3X		10.18	7.34	19.78	35.39	37.49	0.85	5788	5611	7942
Cummulative		8.99	6.5	16.03	36.78	40.68	0.78	6207	6042	8012

Based on Table 7, the coal quality data after the blending process can be observed. The blending results for Seam I show the following values: Total Moisture 9.17%, Inherent Moisture 6.52%, Ash Content 16.97%, Volatile Matter 36.27%, Fixed Carbon 40.24%, Total Sulphur 0.85%, with calorific values of 6132 cal/g (adb), 5959 cal/g (ar), and 8015 cal/g (daf).

DISCUSSION

Detailed Analysis of Coal Seam

Based on the results of proximate and calorific value analysis from the three coal seams studied, it can be concluded that all three are classified as Bituminous – High Volatile A which is Commonly Agglomerating. This classification indicates good quality coal with high volatile matter content and a calorific value highly suitable for main applications such as steam power plants (PLTU) and metallurgical industries. However, each seam exhibits unique and distinct characteristics, which can later be optimized through the blending process.

Seam I is notable for its quite high Volatile Matter (VM) content, which is 39.80% (adb), indicating the coal's ease of ignition. However, this seam also has a significant weakness: the highest ash content among the three seams, at 5.72% (adb), as well as the highest total sulfur (TS) content, at 0.83% (adb). High ash content can reduce combustion efficiency and increase

handling costs and waste, while high sulfur has the potential to cause equipment corrosion issues and emissions of environmentally damaging SO_2. Its calorific value of 7,510 kcal/kg (adb) is still considered very good, although slightly lower compared to Seam II and III.

In contrast, Seam II and III show superior quality in terms of cleanliness. Seam II has a very low ash content (2.58% adb) and equally low sulfur (0.46% adb), accompanied by a calorific value of 7,858 kcal/kg (adb). Seam III is even more spectacular with a very minimal ash content (1.03% adb), making it the cleanest seam, with a peak calorific value of 7,881 kcal/kg (adb). These characteristics make Seam II and III highly valuable and ideal for use independently or as quality-enhancing components in blending.

Blending Efectivity

The blending process carried out by combining coal from one of the high-quality seams (SIM 1, SIM 2, or SIM 3) with low-quality coal (Sample X) proved to be very effective in creating a final product with more homogeneous and consistent quality. Sample X itself has poor quality with very high ash content (19.78% adb) and low calorific value (5,788 kcal/kg adb). The blending results for all three scenarios show a similar pattern: ash content dropped drastically from ~19.78% to around 16.97-16.03%, while the calorific value increased significantly from ~5,788 kcal/kg to around 6,132-6,207 kcal/kg (adb).

Most importantly, the calorific value on a dry-ash-free (daf) basis for all blending results stabilized in the range of 8,012-8,029 kcal/kg. This proves that intrinsically, the quality of the coal material from the main seams is excellent, and it is the impurities (moisture and ash) from Sample X that lower the quality. The blending process successfully diluted these impurities. Overall, this blending strategy not only addresses the issue of quality variability but also creates a coal product that meets market specifications with a GAR (as-received) calorific value of around 6,000 kcal/kg. This success demonstrates that low-quality coal resources (such as Sample X) can still be utilized economically and optimally without having to be discarded, by mixing them proportionally with high- quality coal from Seam I, II, or III. These findings have important implications for production management and marketing strategies to maximize the economic value of all existing reserves.

CONCLUSION

Based on the results of laboratory tests on coal samples conducted at PT. Geoservices Padang, it can be concluded that the quality value of coal at CV. Bara Mitra Kencana varies across the three sampling points. Based on the data from the test results of the coal samples taken at CV. Bara Mitra Kencana, the coal is classified as bituminous – highly volatile A – generally agglomerating, and one of them is utilized for the Ombilin Power Plant (PLTU Ombilin). The quality value of the coal changes after the blending process is carried out.

ACKNOWLEDGMNET

The authors would like to extend their deepest gratitude and appreciation to the management of CV. Bara Mitra Kencana for their generous permission, invaluable support, and full cooperation which enabled this research to be conducted. We are particularly thankful for the opportunity to access the sampling sites and for the provision of the necessary data and samples, which were fundamental to the completion of this study. This contribution has been essential in achieving the objectives of our research.

REFERENCES

1. Arif, I. 2014. **Batubara Indonesia.** Jakarta: PT. Gramedia Pustaka.
2. ASTM D388. **Klasifikasi batubara.**
3. Hardiati, Siti, dkk. 2018. **Blending batubara untuk memenuhi kriteria permintaan pasar ekspor**. Politeknik Akamiga Palembang.
4. Hidayat, Syamsul, dkk. 2021. **Analisis Hubungan Kandungan *Total Moisture*, *Total Sulphur* Dan *Ash Content* Terhadap *Gross Calorific Value* Pada Batubara**. Uniersitas Sumbawa.

5. Kurniawan, I., Aryansyah, Huda. **Analisis Kualitas Batubara Sebagai Penentu Faktor Swabakar**. UNJ.
6. Mardiah, dkk. 2019. **Evaluasi Kualitas Batubara dari Font Penambangan Hingga Stockpike di Pit 1 Banko Barat PT Bukit Asam Tbk Tanjung Enim**. Bangka Belitung: Jurnal Teknik Pertambangan Universitas Bangka Belitung.
7. Belatri, nur., dkk.2021. **Perbandingan Metode BS Terhadap Metode ASTM Dalam Analisis Proksimat Batubara**: Akademi Komunitas Industri Pertambangan Bukit asam.
8. Fadhili, A. M. & Ansosry. 2019. **Analisis Pengaruh Perubahan Nilai *Total Moisture, Ash Content* dan *Total Sulphur* Terhadap Nilai Kalori Batubara Bb-50 di Tambang banko Barat Pt. Bukit Asam, Tbk. Tanjung Enim Sumatera Selatan.** Jurnal Bina Tambang Vol. 4 (3).
9. Purnomo, Hendro, dkk. 2020. **Analisis Pencampuran Batubara Sub-Bituminus Gar-6100 Untuk Memenuhi Pemuatan Kapal Ekspor di PT Bukit Asam Tbk Unit Pelabuhan Tarahan Lampung.** Yogyakarta: Institut Teknologi Negeri Yogyakarta.
10. Rahmawati, Devit, dkk. 2021. **Analisis Perubahan Kualitas Batubara Di *Front* Penambangan terhadap Kualitas batubara di *Stockpile*, Kabupaten Bungo, Provinsi jambi.** Jambi: Universitas Muaro Bungo.
11. Febryanti, dan Yulhendra, dedi. 2021. **Analisis Penentuan Kualitas Batubara Berdasarkan Uji Proksimat di PT. Pelabuhan Universal Sumatera Kabupaten Muaro Jambi, Provinsi Jambi**. Fakultas Teknik Pertambangan. Universitas Negeri Padang.
12. Kurnia, Hilman., dk. 2022. **Evaluasi Kualitas Batubara pada *Front* Penambangan dan *Shipp Loading* di Provinsi Kalimantan Timur**. Sulawesi: Teknik Pertambangan Unersitas Dayanu Ikhasanuddin, Bau-bau.