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Characterization of Some Coal Deposits Quality by Use of Proximate and Sulfur Analysis in The Southern Arm Sulawesi, Indonesia

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ABSTRACT

This paper describes the characteristics of some coal depoasits from Paluda, Padanglampe, Lamuru and Tondongkura (South Sulawesi, Indonesia). The investigation of selected coal deposits in South Sulawesi have been carried out with the aims at elucidation of the coal quality which represented by proximate and total sulfur analyses. Results show that the lower inherent moisture of Paluda coal might be affected by igneous intrusion. In general, the studied coal samples have high ash and sulfur content with the average of 29.01 wt.% and 3.74 wt.% respectively. It was shown that there is no specific trend of the vertical distribution both for ash and sulfur. In term of coal utilization, it is indicated that South Sulawesi coal has constraints and challenging due to the high ash and sulfur. It is therefore suggested to reduce ash and sulfur content as much as possible if the coal is used as direct solid fuel in power plant or industry.

Keywords: proxymate, sulfur, Paluda, Lamuru, Tondongkura, Padanglampe.

1. INTRODUCTION

Coal is the cheapest energy source in world and it will continue to play a significant role in industrial utilization for the future. Steam power plant is the industry that use highest coal followed by cement factory, small scale industry and house hold sector. Indonesia has coal resources for more than 120 billion tons and reserves have more than 31 billion tons [1]. Majority of Indonesian coalsare classified as low rank due to the higher moisture content and lower calorific value. The only about 231 million tons or 0.2% of the total of coal resources in the country are located in South Sulawesi [2].

Coal deposits in South Sulawesi have been investigated by some researchers [3-5]. They showed that such deposits have relatively higher ash and total sulfur content. These may cause constraints in the utilization of coals as energy sources. Therefore it is interesting to study in more detail about the composition of some coal deposits particularly ash and total sulfur content. This is very useful in upgrading the quality of coals by removing these components prior to utilization.

A better understanding on the occurrence of minerals and inorganic compositions of coal is also important to many aspects of the geology, quality assessment, mining and beneficiation [6-20]. One of the most widely used sources of data on these inorganic matter is the chemical analysis of the ash remaining after high temperature combustion, either in the laboratory or in a working industry plant [17].

The aim of this study is to determine the quality characteristics of analyzed samples, to find out the vertical distribution of ash and sulfur content within the some coal seams and to assess the impact of utilization of these coals as energy sources in industry.

2. GEOLOGICAL BACKGROUND

In term of geological background, coal deposits in South Sulawesi are associated with sedimentary sequence of Palaeogene (Mallawa Fm) and Neogene deposits (Walanae Fm) respectively [21]. Mallawa Formation is the major coal-bearing strata consist of sandstone, conglomerate, claystone and coal seams. These strata were formed in syn-rift deposition where the rifting occurred presumably in a northwest-southeasterly trending rift valley [1]. The coal seams were deposited in the last stage of syn-rift system. This has resulted afluviatile-locustrine sedimentation which provide deltaic deposition prior to the post-rift deposition take place.

3. SAMPLING AND ANALYTICAL METHOD

Total of twenty coal samples were collected from four different localities. Samples were taken ply by ply with channel sampling method. Three samples were collected from Padanglampe coalfield while four samples from Paluda coalfield. Both are included in the Barru Regency. Other six samples were taken from two different seams which situated at Tondongkurah coal mine in Pangkep Regency and the last seven samples were collected from Lamuru coal mine located in Bone Regency (Fig.1).

All samples collected from the field were further air-dried at the room temperature prior to submit for analysis. Proximate analysis including inherent moisture, ashand volatile matter wasperformed by means of ASTM standard D3173, D3174, and D3175 respectively in a muffle furnace. Total sulfur content ofthe analyzed samples were measured by Leco SC-144DR analyzer.

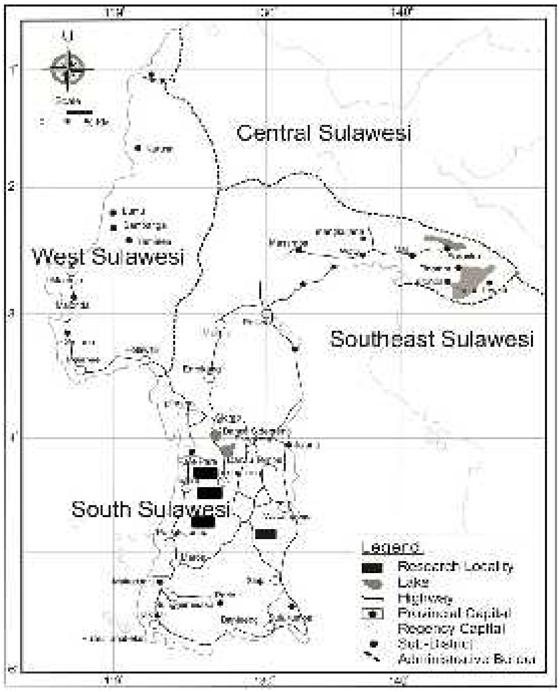

Figure 1. Geographic map showing the locations of coal sample position in South Sulawesi.

4. RESULTS AND DISCUSSIONS

A. Field appearance

Results of field examination show that the thickness of studied coal seams is generally thin within the range between 1.10 to 3.50 m. They display semi bright and dull with the fractures were commonly even. Pyrite was easily detected mainly as fractures filling after the coal were broken.

B. Proximate Analysis

Table 1 shows the resuls of proximate and total sulfur analysis of coal samples. With the exception of Paluda Coal (vary from 1.59 to

2.27 wt.%), the moisture content of the analyzedsamples from three other localities (Padang Lampe, Tondongkura and Lamuru) has wide range value vary from 6.5 to 12.9 wt.% with average value of 10.30 wt.%. The highest moisture content of studied coal is found in the ply LM-5 from Lamuru coal seam. Lower moisture content of Paluda coal to compare to other three locations of coal can be estimated that the coals are influenced by the intrusion of igneous rock.

The studied coal samples show higher variability ash yields (from 6.91 to 82.1 wt.%; Table 1). The value of ash content from Paluda, Tondongkura and Lamuru coal show irregular variation from the upper to the lower ply of each seam. Sole exception is the coal sample from Padang Lampe, the value of ash content show a systematic variation from the upper to the lower ply of seam (the value increases from the upper to the lower ply with value range from 12.98, 23.38 to 40.09 wt.% respectively; Table 1). As shown in Table 1, the highest content of ash is found in the ply PD-2 from Paluda coal seam with value 82.12 wt.%.

Unlike to the ash content, regular variation of volatile matter is only found in the Paluda coal seam. The value increases from the upper to the lower ply respectively with a value vary from 9.05 to 35.74 wt.% (Table 1). The highest of volatile matter content is observed in sample ply TK-5 from Tondongkura coal seam. Moreover, coal samples from Padang Lampe, Tondongkura and Lamuru indicated that there is no systematic variation of volatile matter in the vertical profile of studied coal seam. Volatile matter content shows relatively high values which is characteristics of Sulawesi coal**.**

Fixed carbon (FC) content of studied coal samples are also shown in Table 1. The result shows a random value of each coal samples. There is no spesific and systematic variation in vertical profile of studied coal seams. The values of fixed carbon varies from 6.01 to 48.77 wt.% for coal sample from Paluda; 16.38 to 26.83 wt.% for coal sample fromPadang Lampe; 9.07 to 30.79 wt.% for coal sample from Tondongkura and 4.73 to 34.17 wt.% for coal sample from Lamuru. Highest fixed carbon content of studied coal was detected in the sample ply PD-4 with value of 48.77 wt.% (Table 1).

Table 1. Results of proximate and total sulfur analyses of studied coal samples

Locality	Sample No.	Proximate analysis (wt.%adb)				Total Sulfur (wt.%adb)
		IM	Ash	VM	FC	
Paluda Coalfiled (Barru Regency)	Ply PD-1	1.67	75.00	9.05	14.28	1.08
	Ply PD-2	2.27	82.12	9.60	6.01	2.06
	Ply PD-3	1.99	36.63	24.54	36.84	4.52
	Ply PD-4	1.59	13.89	35.74	48.77	5.37
Padang Lampe Coalfield (Barru Regency)	Ply PL-1	9.64	12.98	38.49	21.83	3.70
	Ply PL-2	9.88	23.38	39.90	26.83	3.25
	Ply PL-3	7.80	40.09	35.28	16.83	1.84
Tondongkura Coalfield (Pangkep Regency)	Ply TK-1	11.09	10.16	48.46	30.29	2.80
	Ply TK-2	12.25	8.25	48.70	30.79	1.96
	Ply TK-3	11.60	14.68	46.50	27.22	3.86
	Ply TK-4	10.86	47.08	32.98	9.07	2.33
	Ply TK-5	8.25	17.47	54.51	19.76	3.03
	Ply TK-6	12.96	21.39	43.13	22.52	6.01
Lamuru Coalfield (Bone Regency)	Ply LM-1	7.38	40.75	31.23	20.64	11.86
	Ply LM-2A	10.35	11.54	44.87	33.24	5.04
	Ply LM-2B	10.82	8.12	47.39	33.66	4.65
	Ply LM-3	6.54	63.68	25.05	4.73	3.34
	Ply LM-4	12.40	6.91	46.51	34.17	4.13
	Ply LM-5	12.91	9.24	44.94	32.91	2.34
	Ply LM-F	9.95	36.92	33.28	19.84	1.54

C. Sulfur Analysis

As shown inTable 1, total sulfur content of studied coal sampleshas minimum value of 1.08 % and maximum value of 11.86%. The average of total sulfur contentis 3.74%,implying that studied coal is classified as high sulfur (Wood, et al.,1983). The value of total sulfur content of Paluda coal seam increases from the upper ply to the lower ply of coal seam respectively (range from 1.08%, 2.06%, 4.52% and 5.37%). The highest total sulfur content of Paluda coal seam is found in the ply of PD-4 with value of 5.37%. On the other hand, total sulfur content of coal seam from Padang Lampe Coalfield decreases from the upper to the lower ply of coal seam. The lowest total sulfur value is found in the ply of PL-3 (1.84%). The total sulfur content of Padang Lampe Coalfield ranges from 1.84 % to 3.70%. Along the seam of coal from Tondongkura and Lamuru Coalfield, there is no systematic variation of total sulfur content can be observed (Table 1). The highest total sulfur content of all studied coal samples has been found in ply LM-1 of coal seam from Lamuru Coalfield with a value of 11.86% and categorized as super high sulfur [23]. Studies of some sulfur content on coal have been done [24-27]. The result implies that coals marine roof rocks have higher sulfur contents than those with fresh-or brackish-water of rocks. High total sulfur content are characteristically those in which sulfate-bearing seawater has infiltrated the original fresh to brackish water peat mire during or after deposition. The results of this study in Sulawesi coals are consistent with their stratigraphic units. Mallawa Formation as a coal bearing formation was overlaid by the shallow manine and mixed carbonat rocks of Tonasa limestone Formation. Tonasa Limestone Formation was deposited initially as part of a transgressive sequence, in the midst of an exccedingly complex tectonic area [28].

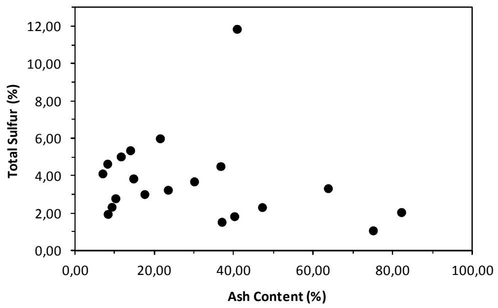

Figure 2 Binary plots between ash and total sulfur content

Binary plot of ash versus total sulfur content is shown in the Figure 2. From the diagram, it can be concluded that there is no significant relation between ash and sulfur content. This is might be due to the different affinity of sulfur element in coal.

D. Implication for the Coal Utilization

Regarding to utilization of South Sulawesi coal in industry, it can be inferred that some negative impact will appear particularly on the sulfur content. Coal used as solid fuel at the coal fired steam power plant may cause air pollution. In addition, sulfur elements is corrosive, so that it may have detrimental effects on the surrounding environment. The total sulfur content is a major consideration in coal utilization. Therefore the characteristic of coal quality should be considered before utilized.

5. CONCLUSSION

The analysis of proximate has been done with the aims to determine moisture, ash, volatile matter and fixed carbon contents in the coal sample. With the exception of Paluda Coal, the moisture content of the analyzed samples from three other localities (Padang Lampe, Tondongkura and Lamuru) has wide range value vary from 6.5 to 12.9 wt.% with average value of 10.30 wt.%. The highest moisture content of studied coal is found in the ply LM-5 from Lamuru coal seam. Lower moisture content of Paluda coal to compare to other three locations of coal can be estimated that the coals are influenced by the intrusion of igneous rock. The studied coal samples show higher variability ash yields. The value of ash content from Paluda, Tondongkura and Lamuru coal show irregular variation from the upper ply to the lower ply of each seam. Sole exception is the coal sample from Padang Lampe, the value of ash content show a systematic variation from the upper to the lower ply of seam. The highest content of ash is found in the ply PD-2 from Paluda coal seam. A systematic variation of volatile matter was observed in the Paluda coal seam. Coal samples from Padang Lampe, Tondongkura and Lamuru indicated that there is no systematic variation of volatile matter in the vertical profile of studied coal seam. Volatile matter content shows relatively high values which is characteristics of Sulawesi coal**.** The result of fixed carbon shows a random value of each coal samples. There is no spesific and systematic variation in vertical profile of studied coal seams. The Highest fixed carbon content of studied coal was detected in the sample ply PD-4 with value of 48.77 wt.%. Total sulfur content of studied coal samples has minimum value of 1.08 wt.% and maximum value of 11.86%. The highest total sulfur content of all studied coal samples has been found in ply LM-1 of coal seam from Lamuru Coalfield with a value of 11.86 wt.% and categorized as super high sulfur. The data of this study was not only needed for science information but also to the local goverment and mine investors. The total sulfur and ash content of coal had an important role for consideration of coal exploitation and utilization. From the result of the analysis, it can be concluded that there is no significant relation between ash and sulfur content in the coal samples. This is might be due to the different affinity of sulfur element in coal. High sulfur content of study coals might be caused by the depositional of coal deposit in the shallow marine environment (influenced by Tonasa Limestone Formation).

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