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Coal Characterization based on Coal Mineralogy Tests in Salopuru Village Barru District

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Abstract

Coal characterization based on sulfur content is an important aspect in assessing the quality and usefulness of coal for various applications. This research was conducted to study the characterization of coal based on mineralogical tests using scanning electron microscopy (SEM) and X-ray diffraction (XRD) methods, how this information can help in dealing with sulfide elements in the coal. Sulfur in coal can be found in several different chemical forms, depending on the geology and environmental conditions in which the coal was formed. The content and type of sulfur in coal can influence coal management and use strategies, especially in the context of increasingly stringent environmental regulations stipulated in the Indonesian government's Environmental Regulation No. 4 of 2014 Article 7. Characterization of sulfur is divided into low, medium and high sulfur. Mineralogical characterization of coal based on scanning electron microscopy (SEM) tests with analysis results namely Oxygen (21.79%), Sodium (0.39%), Magnesium (0.32%), Aluminum (2.78%), Silica (1.91%), Sulfur (5.78%), Potassium (1.22 %), Calcium (1.26 %), Manganese (0.51 %), Iron (64.05 %) and X-ray diffraction (XRD) with analysis results namely Oxygen (44.1 %), Silica (28.2 %), Iron (19.5%), Sulfur (6.9 %), Potassium (1.0 %), and Hydrogen (0.2 %). Therefore, the sulfur content in coal is included in the high sulfur category because the level is >3% and will affect the surrounding environment because the content exceeds the sulfur quality threshold value.

Keywords: Coal, Sulfur, Characterization, Mineral, Element

Pendahuluan

Coal is a type of fossil fuel formed from the remains of ancient plants which have undergone chemical and physical changes over millions of years under high pressure and heat in the soil layers. Coal is one of the alternative energy sources in Indonesia with quite large amounts of resources and reserves. In the future, coal will have good prospects and opportunities for development. As oil and gas fuels become increasingly limited as the need for industrial activities increases, coal can be used as an alternative energy in the future. Coal is composed of maceral, mineral and moisture components. Coal quality is greatly influenced by the parameters of ash, sulfur and calorific value (Avicenna *et al*., 2019) [3].

Coal characteristics based on physical mineralogical tests include an in-depth understanding of the mineral composition, structure and physical properties that influence the use and processing of coal. Coal characterization based on sulfur content is an important aspect in assessing the quality and usefulness of coal for various applications. The sulfur content in coal can have a significant impact on the environment and the technology of its use. The smaller the grain size of the limestone, the higher the pH value can be maintained and the larger the grain size of the limestone, the lower it is maintainable pH value. (Yusuf F.N, *et al*, 2021) [14].

This research was conducted to study the characterization of coal based on mineralogical tests using the scanning electron microscopy (SEM) method and X-ray diffraction (XRD) of coal from Salopuru Village, Barru Regency, South Sulawesi Province, Indonesia, how this information can help in dealing with sulfide elements on the coal.

Research Methods

The research location is located in Salopuru, Pujananting Regency, Barru Regency, South Sulawesi Province, Indonesia, which is located at coordinates X= 803151 and Y= 9486972. A map of the research location can be seen in the Fig 1.

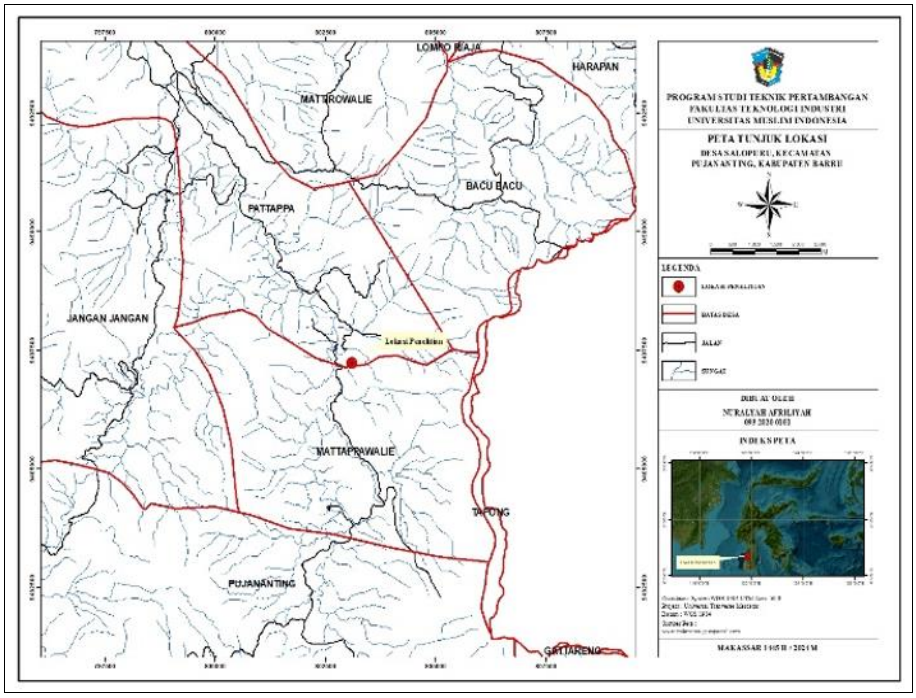

Fig 1: Research Location Map

The data taken for research is primary and secondary data. Primary data is data collected by making direct observations in the field such as sampling coordinate points, results of Scanning Electrone Microscopy (SEM) analysis, results of X-Ray Diffraction (XRD) analysis. Secondary data is research data that has been collected by other people or not directly obtained by researchers from the field, such as maps of research locations and research documentation.

At the sample processing stage, coal samples that had been taken from the Salopuru Area, Pujananting District, Barru Regency, South Sulawesi Province were then taken to the Minerals Processing Laboratory of the Mining Engineering Study Program, Faculty of Industrial Technology, Indonesian Muslim University. The stages of sample preparation activities can be seen on the next page of the Fig 2.

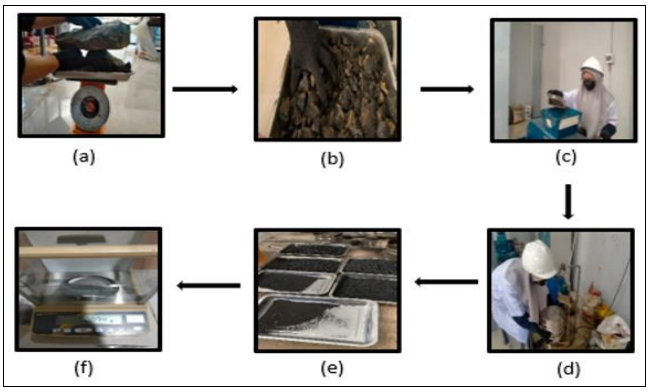

Fig 2: Kegiatan preparasi sampel

The Sample Preparation Process Consists of: (a) Sample, (b) Sample Size Reduction, (c) Crushing the Sample Using a Double Roll Crusher, (d) Sifting the Sample, (e) Separating the Sample According to Size, (f) Weighing the Sifted Sample.

At the data processing stage, coal samples that have been obtained and prepared to the desired size are then processed, after carrying out analytical testing at the Microstructure Laboratory, Faculty of Engineering, Indonesian Muslim University, for Scanning Electron Microscopy (SEM) analysis, to observe surface morphology and structure, and chemical compounds contained in the coal samples. Next, analytical testing was carried out using X-Ray Diffraction (XRD) analysis at the Mineral Processing Analysis Laboratory, Faculty of Engineering, Hasanuddin University, to determine the structure and composition contained in coal.

Research Result

1. Abbreviation Data

Outcrop data can be seen in the Fig 3.

Fig 3: Coal Samples Salopuru

a. Outcrop Data

Rock Type:	Non-clastic sediment
Location:	Salopuru
Dimensions:	3 x 4 meters

b. Litology Data

Weathered color:	Brown
Fresh Color:	Black
Textur:	Non Clastic
Compactness:	*Soft*
Sediment Structure:	Layered

c. Geomorfological Data

Relief:	Sloping

2. Analysis Results *Scanning Electron Microscopy* (SEM) EDX

SEM analysis was carried out to determine the surface characteristics of the material. The following are the results of analysis of Salopuru coal, Patappa Village, Barru Regency using Scanning Electron Microscopy (SEM) analysis.

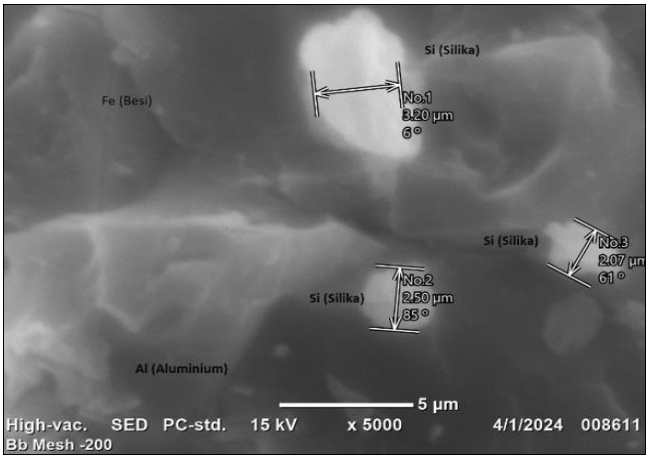

Fig 4: Test Result SEM Enlargement 5000x

The results of the 5000x Magnification value analysis clearly show the elements contained in the coal samples, namely the element silica (Si) with an average grain size of 2.59 micro meters, the element Aluminum (Al) and the element Iron (Fe).

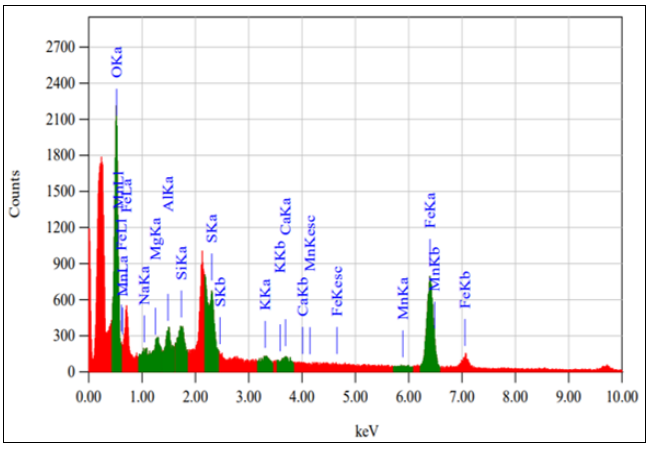

Fig 5: Test Result EDX Coal

Table 1: Test Result EDX Coal Salopuru

S. No	Element	Ec Tegangan Emisi Minimum (keV)	Massa %	Atom %	Mol %
1	O	0,525	21,79	45,99	-
2	Na	1,041	0,39	0,57	0,55
3	Mg	1,253	0,32	0,44	0,86
4	Al	1,486	2,78	3,48	3,38
5	Si	1,739	1,91	2,29	4,46
6	S	2,307	5,78	6,09	11,83
7	K	3,312	1,22	1,05	1,02
8	Ca	3,690	1,26	1,06	2,06
9	Mn	5,894	0,51	0,31	0,61
10	Fe	6,398	64,05	38,72	75,23
Total		**27,645**	**100**	**100**	**100**

The results of the EDX analysis in Fig 5 and Table 1 show that the most dominant elements with the highest values are Iron (Fe) at 64.05%, Oxygen (O) at 21.79%, Sulfur (S) at 5.78%, Aluminum (Al) of 2.78%, Silica (Si) of 1.91%, Calcium (Ca) of 1.26%, Potassium (K) of 1.22%, Manganese (Mn) of 0.51%, Sodium (Na) 0.39% and Magnesium (Mg) 0.32%. The results of the analysis show that in this sample the most dominant element is the element Iron (Fe).

3. Result and Discussion Analysis *Difraction Sinar-X* (XRD)

X-Ray Difraction (XRD) analysis was carried out to determine the mineral composition contained in the coal which contains the elements Fe, Si and Al. analysis using XRD with a diffractogram pattern provides a series of diffraction peaks that vary in intensity along a certain 2θ value. The diffraction pattern of coal samples analyzed by XRD is shown in the image below.

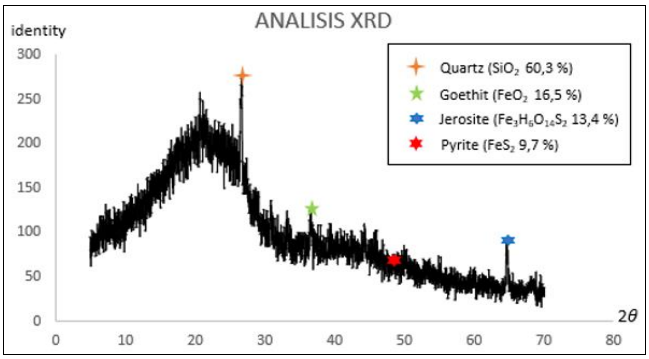

Fig 6: Test Result XRD Coal Salopuru

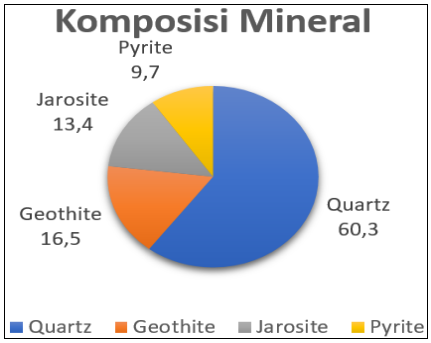

Fig 7: Test Result XRD (Komposisi Mineral) Coal Salopuru

The results of the analysis of coal samples contain 60.3% Quartz (SiO_2) minerals. Quartz is a mineral that is very resistant to weathering and is found in many types of rock, both igneous, sedimentary and metamorphic. Quartz can be formed through a sedimentation process from the weathering of existing rocks. The appearance of the minerals in this coal is due to the regional geological conditions in this area which are found in the Mallawa formation. This rock shows the impression of layering, when fresh it is brownish yellow in color, has a rough clastic texture, contains the mineral quartz. The formation of quartz minerals, namely eroded and transported particles that settle and form sedimentary rocks such as quartz sand. Jerosite mineral ($Fe_3H_6O_{14}S_2$) 13.4% is a secondary sulfate mineral that is often found in coal, especially in coal that has undergone oxidation or weathering. Jarosite can reduce the quality of coal because it contains sulfur and can cause corrosion problems in combustion equipment. The mineral Pyrite (FeS_2) 9.7% is a coal mineral from the sulphide minerals group. The process of forming pyrite minerals in coal is the peatification stage, plant material accumulated in

swamps undergoes anaerobic decomposition by microorganisms. This process produces dissolved organic compounds and gases such as H_2S and SO_2. After the peatification stage, geochemical and hydrogeological processes can cause pyrite migration and precipitation. Groundwater rich in sulfate can infiltrate into coal seams and react with existing iron minerals, forming pyrite. Geothite mineral (FeO2) 16.5% is an iron oxide-hydroxide mineral commonly found in coal, especially in coal that has undergone weathering or oxidation. Goethite is an undesirable impurity mineral in coal because it can reduce the calorific value and increase the ash content. If the XRD results are correlated with the SEM-EDX analysis results, there are similarities where the EDX results have the highest element of Iron (Fe) while the Quite a lot can be seen from the iron-bearing minerals, namely Geothite, Pyrite and Jerosite.

Conclusion

Based on the results of the research conducted, it can be concluded that

1. Mineralogical characterization of coal based on SEM EDX and XRD of iron-bearing minerals has the highest element of Iron (Fe) while XRD results show that quite a lot of Iron (Fe) minerals can be seen from iron-bearing minerals namely Geothite, Pyrite and Jerosite.
2. The sulfur content in coal based on scanning electron microscopy (SEM) analysis shows that the sulfur content in Salopuru coal is 5.78%, while the x-ray diffraction (XRD) analysis shows that the sulfur-bearing mineral content is Jerosite and Pyrite. It can reduce the quality of coal and cause environmental pollution because it contains sulfur and can cause corrosion problems in combustion equipment.

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