Study of Ash and Total Moisture Effects on Calorific Value in Coal Seam at West Banko Field, PT. Bukit Asam, Tbk., Tanjung Enim, South Sumatra

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Abstract. In the coal mining industry, the coal quality is as crucial as the coal quantity because it can impact the coal usefulness. The quality of coal itself can be influenced by several factors, such as moisture content, ash, sulfur, and volatile matter. This study tries to understand the coal quality and its variation in the Muara Enim Formation of South Sumatra Basin. The research was conducted in the West Banko field, PT. Bukit Asam, Tbk., Tanjung Enim, South Sumatra. By using linear regression, this study found that increasing ash and total moisture content will lead to a decreasing amount of the calorific value. Additionally, the value of coal quality content such as ash and total moisture can be affected by the depositional environment, sedimentation rate, and coal characteristics in the study area thus affecting the calorific value. Transitional lower delta plain depositional environment with low sedimentation rate and coarsening upward sandstone sequence indicates lower ash and total moisture content in the study area. The highest calorific value found in the study area is in C1 seam, this can be seen from the ash quality and total moisture distribution map which inversely proportional to the calorific value.

Keywords: Ash, Total Moisture, Calorific Value, Coal Seam, Tanjung Enim

1. Introduction

Coal is one of the energy sources that is often used for many years. Coal is still an important part of energy demand in Indonesia. Coal itself is still economically valuable compared to other energy. Exploration activities can be used to obtain new coal reserves which can be used as energy in the future. Before coal exploitation activities, there is an exploration stage that can facilitate the determination of coal reserves. The exploration activity can be carried out by geological mapping, geophysical surveys, laboratory analysis, and drilling. Besides the potential quantity and quality of coal can be determined from these exploration activities. The quality of coal itself can be affected by several factors such as moisture content, ash, sulfur, and volatile matter. The method that is often used to determine the comparison of coal quality is quantitative descriptive. This research aims to determine the effects of ash and total moisture on calorific value in coal which contributes to coal quality in the study area. The research location is located in Field X, Banko Barat, PT. Bukit Asam, Tbk., Lawang Kidul District, Muara Enim Regency, South Sumatra (Figure 1).
2. Geological Overview of The Research Area

The research area, geologically located in South Sumatra Basin with back-arc basin characteristic which is bounded by the presence of Bukit Barisan in the southwest and a pre-tertiary Sunda shelf in the Northeast [3] (Figure 2). The coal-bearing formation in the research area is Muara Enim Formation which consists of 4 members M1, M2, M3, and M4 [11].

Geological conditions in the study area are included in simple geological conditions according to SNI 5015 (2011) which can be seen from the tectonic aspects, sedimentation aspects, and quality variations of the research area. The tectonic aspect is influenced by the southwest – southeast trend syncline. This is also supported by field data, where there is a relatively gentle sloping of syncline of around 20-30°. The study area had no faults and no intrusion.

Sedimentation aspects consist of continuity of layers, variation in thickness, and seam branching. The research location has a continuous layer with a range of thousands of meters and no visible thinning of bed observed. The branching of seam can be seen in the C seam where the C1 and C2 seams are obtained. Thickness variations in the study area were obtained through statistical analysis, namely by using the coefficient of variation to obtain homogeneous or heterogeneous data. The coefficient of variance was obtained amounted to 20.62%. This suggests that the thickness variations of the study area are heterogeneous [10].

The variation in coal quality in the study area can be seen from the coal classification using ASTM (2004). In the research area, the rank of coal is dominated by High-volatile B Bituminous Coal. This proves that the quality distribution is homogeneous or uniform.

Figure 2. Geological Overview (Amijaya & Litke, 2005)
3. Methods

Literature study is conducted which is used to support the research process, ultimately to understand the geological conditions around the study area. Furthermore, coal quality data collection is carried out in PT Bukit Asam Tbk. in the form of ash content, moisture content, and calorific value using proximate analysis. In figure 3, it can be seen that research methodology. The data obtained are then processed using box and whisker plot to observe the data distribution and mean of the data, linear regression to observe the effects on total moisture, and ash to calorific value and making coal quality distribution map. The results of this processing are in form of graphs on coal quality, coal correlation, and coal distribution maps. The final step is to determine the correlation between the value of ash and moisture content on the caloric value.

![Research Methodology Diagram](image)

Figure 3. Research Methodology

4. Results and Discussion

4.1 Relationship of Ash to Calorific Value

The distribution of ash in the study area has a northwest-southeast trend. The value of the ash content in the study area varies considerably. The distribution of ash content values in seams A1, A2, and B1 have increased to the west. In seams B2, C1, and C2 ash is distributed evenly whilst seam C has increased in the center of the research area.
determined by using a linear regression graph. It can be seen that the value of $y = -0.0043x + 29.975$ with the coefficient value $R^2 = 0.3883$. The visible trend value has a negative x value, this indicates that there is an inverse relationship, the higher the ash content, the lower the calorific value of the coal.

In Figure 5, it can be seen that there is a data change that is not too significant on the ash content of each coal seam using a box and whisker plot. The highest value of ash content was found in C1 seam and the lowest was in seam A2. The average value of the ash content of each coal seam from A1 seam to C2 seam is 4.15 (% adb), 3.52 (% adb), 3.77 (% adb), 4.93 (% adb), 3.9 (% adb), 4.71 (% adb), and 4.24 (% adb).

The value of ash content in the study area can interpret the conditions of the depositional environment and sediment supply. The ash content in coal itself comes from inorganic materials which are formed from mineral changes due to the combustion process. The higher the ash value, the higher the impurity material during sedimentation and the lower the ash value, the less impurity material will be during the sedimentation process. According to Nasution et al (2017), if the ash content in the study area is low, it can be interpreted as a depocenter area, which is a sedimentary rock that has a maximum thickness.
According to (Oresajo, 2016) the value of ash content above 15% is classified as high ash content. In the study area, the ash content is relatively low with 15% adb. In the study area, it can be interpreted that the type of swamp that has a low ash content is associated with the raised swamp type. This type of raised swamp is an area where the annual rainfall is higher than the rate of evaporation. The swamp has a relatively high topography which allows a lack of sediment supply during coal deposition[9].

4.2 Relationship of Total Moisture to Calorific Value

The distribution of total moisture (TM) quality in the study area has a northwest-southeast trend. The distribution of TM values in the study area varied. In seams A1, A2, B1, B2, and C the TM content is high in the western part of the research area whilst on the C1 and C2 seams have increased in the southern part.

From figure 7, it can be seen that the relationship between the total moisture content and the calorific value using a linear regression graph. It can be seen that the value of y = -0.0039x + 50,354 with the
coefficient value $R^2 = 0.151$. The visible trend value has a negative x value, this indicates that there is an inverse relationship, the higher the total moisture content, the lower the calorific content value in coal.

In figure 8, it can be seen that the total moisture value above has a not too significant difference using the box and whisker plot. The average value of TM on each coal seam, from A1 seam to C2 seam, is 23.94 (% ar), 25.97 (% ar), 27.53 (% ar), 28.11 (% ar), 26.55 (% ar), 27.70 (% ar), and 28.94 (% ar). The highest average value is in seam C2 and the lowest average value is in seam A1.

What can affect the value of TM is the grain size of the coal. The smaller the grain size of coal, the TM value can increase, and this can lead to a decrease in the calorific value of coal (Budiman et al., 2017). The compactness of the rocks can also affect the ash and moisture content of the coal. This is because the compactness of the rocks is influenced by the amount of porosity. Large density will have a small rock porosity value and vice versa [1].

4.3 Calorific Value Distribution

It can be seen on the map of the distribution of caloric values in figure 9 seams A1, A2, B1, B2, C1, and C2, the caloric value has increased to the west and seam C has increased to the east of the research area. The value of the distribution of calories is inversely related to the value of the quality distribution of ash and moisture content.
5. Conclusion

The results of this study is to determine the effect of ash and total moisture on calorific value of coal which contributes to the quality of coal in the study area. The value of the calorific value can be affected by the value of the ash and moisture content. Based on the linear regression graph of the ash and moisture versus calorific value, a negative x value is obtained, which indicates that the value is inversely related. Increasing ash and moisture content in coal will result in low calorific value. The high and low ash content values are caused during the sedimentation process whilst the high and low moisture content values are caused by the porosity of the coal.

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