Coal handling quality from pits to stockpiles to market specifications

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Abstract. In the coal trade, coal quality becomes the main thing that must be consider. The quality of coal that is not following the specifications desired by consumers causes coal prices below. Parameters of coal quality consist of calorific value, water content, an ash content of flying substances, and sulfur content. The quality of this coal will always recheck with every change of place. Before coal is sold, it is better to monitor the quality of the coal starting from the pit. At the coal quality monitoring location, there are four seams, including seam A1, seam A2, seam B and seam C. Monitoring of coal quality is carried out at seam C to be mined. Monitoring of coal quality from the pit to the stockpile is done by taking representative samples from drilling, mining, and stockpile activities. Then the samples were analysed by proximate analysis. Drilling samples was taken by coring sampling from eight drill points. Sample from the pit are taken by channel sampling method, in the mining pit sample are divided into three parts, namely the upper part (coal with 10 cm thick clay insert, called layer 1), the second middle part (coal with 20 cm thick clay insert, called layer 2 ) and the bottom three (coal without clay insertion, called layer 3). The purpose of the division is carried out as a handling coal from being mixed into three parts. Samples from the stockpiles are taken by grab sampling method from three stockpiles originating from layer one, layer two, and layer three. For layer one coal, the difference in ash content in pits and stockpiles is 1.6%, the difference in total sulfur content in pits and stockpiles is 0.7%. For layer two coal, the difference in ash content in pits and stockpiles is 1.5%; the difference in total sulfur content in pits and stockpiles is 0.7%. In layer three. The difference in ash content in pits and stockpiles is 1.5%, the difference in total sulfur content in pits and stockpiles is 0.7%.

1. Introduction
In the coal trade, coal quality becomes the main thing that must be considered. The quality of coal that not given with the specifications desired by consumers causes coal prices to below. The main parameters of coal quality include calorie value, water content, the ash content, mineral matter content, and sulfur content [1]. The quality of this coal will always be checking with every coal move. Before coal is sold, it is better to monitor the quality of the coal starting from the pit. This monitoring activity aims to monitor changes in coal quality, from drilling, pits to stockpiles. Monitoring was carried out so that the coal reaches the hands of consumers following with the desired coal specifications [2].

2. Methodology research
The methodology for monitoring coal quality is carried out in 3 stages:

- Sampling from coring to determine the initial quality of coal.
• Sampling from the pit to determine the quality of coal after mining.
• Sampling from the stockpile to find out the quality of coal that is ready for sale.

2.1. Sampling from coring
Sampling is done on the results of core drilling with the type of sample in the form of a touch core (Agus, 2-17). The touch core samples are stored in a 5-meter long core of 1 meter each (showing in Figure 1). In this study, the number of core drilling points taken for example was 8 drill points as an analysis of coal quality including BH-01, BH-02, BH-03, BH-04, BH-05, BH-06, BH-07, and BH-08. The coal seam density at this research site indicated that there were 4 coal seams, including seam A1, seam A2, seam B and seam C with varying thicknesses.

![Figure 1. Core drilling sampling.](image)

2.2. Sampling from the pit
Coal mining operations are focused on-seam C, so that the observation of the quality of coal on the front of the work is divided into three parts, including layer one, layer two and layer three, with each layer 2 m in thickness (Figure 2).

In this study, the quality of coal in the mining pit is divided into three parts, the first part consists of the quality of the top coal (coal with 10 cm thick clay parting, less than referred to as layer one), the second part consists of quality middle coal (coal with parting) 20 cm thick clay, less than referred to as layer two and the third part consists of the quality of the bottom coal (coal without parting) clay.

At the time of coal extraction, the parting still taken because of the consideration that the mechanical equipment used is difficult to separate the parting layer. Relevant of the distribution is done in an effort so that the coal into the three parts is not mixed, to maintain the quality of the coal. Sampling is done in the pit mining by channel sampling.
2.3. **Sampling from stockpile**

Coal in the stockpile is resampled. Aims to determine changes in the quality of mining results, until the coal arrived at the stockpile. Taking samples at the stockpile (production sampling) by grabbing the sampling method.

Furthermore, an analysis of the average quality of coal for layer 1 stacks (coal with 10 cm parting thickness), layer 2 stacks (coal with 20 cm parting thickness) and layer 3 stacks (coal without partings clay).

### 3. Result and discussion

#### 3.1. Analysis of changes in the quality of coal in the mining pit with stockpiles

| Location | Sample Code | Total Moisture (%) | Ash Content (%) | Volatile Matter (%) | Fixed Carbon (%) | Total Sulphur (%) | Calorific Value (Kcal/kg) |
|----------|-------------|--------------------|-----------------|--------------------|-----------------|-------------------|--------------------------|
| Pit      | ABS-C1-1    | 22.0               | 1.6             | 35.2               | 42.0            | 1.5               | 6134                     |
|          | ABS-C2-1    | 22.2               | 1.3             | 35.5               | 41.9            | 1.2               | 6134                     |
|          | ABS-C3-1    | 23.4               | 1.1             | 35.7               | 40.4            | 1.3               | 6176                     |
| Stock pile | ABS-C1-1  | 28.4               | 2.7             | 40.5               | 43.9            | 1.5               | 6048                     |
|          | ABS-C2-1    | 25.6               | 2.1             | 39.3               | 44.4            | 1.5               | 6082                     |
|          | ABS-C3-1    | 25.1               | 3.7             | 37.9               | 43.4            | 1.7               | 6066                     |

| Location | Sample Code | Total Moisture (%) | Ash Content (%) | Volatile Matter (%) | Fixed Carbon (%) | Total Sulphur (%) | Calorific Value (Kcal/kg) |
|----------|-------------|--------------------|-----------------|--------------------|-----------------|-------------------|--------------------------|
| Pit      | ABS-C1-2    | 24.1               | 1.1             | 36.4               | 41.4            | 1.3               | 6157                     |
|          | ABS-C2-2    | 23.9               | 1.3             | 36.4               | 42.8            | 0.8               | 6112                     |
|          | ABS-C3-2    | 23.1               | 1.8             | 35.7               | 42.0            | 0.6               | 6157                     |
| Stock pile | ABS-C1-2  | 25.4               | 2.8             | 42.3               | 42.6            | 1.5               | 6166                     |
|          | ABS-C2-2    | 28.4               | 3.4             | 40.6               | 43.1            | 1.4               | 6064                     |
|          | ABS-C3-2    | 28.3               | 3.4             | 29.5               | 43.1            | 1.5               | 6032                     |

**Figure 2.** Coal sampling from pit.
Table 3. Coal quality test layer 3 from pit and stockpiles layer 3.

| Location   | Sample Code | Total Moisture (%) | Ash Content (%) | Volatile Matter (%) | Fixed Carbon (%) | Total Sulphur (%) | Calorific Value (Kcal/kg) |
|------------|-------------|--------------------|-----------------|--------------------|-----------------|-------------------|--------------------------|
| Pit        | ABS-C1-3    | 33.6               | 1.2             | 36.1               | 41.0            | 1.2               | 6175                     |
|            | ABS-C2-3    | 23.0               | 1.3             | 35.5               | 41.9            | 1.2               | 6134                     |
|            | ABS-C3-3    | 21.7               | 1.1             | 35.7               | 40.4            | 1.3               | 6176                     |
| Stock pile | ABS-C1-3    | 28.3               | 2.7             | 39.5               | 43.8            | 1.7               | 6016                     |
|            | ABS-C2-3    | 28.4               | 2.7             | 40.5               | 43.9            | 1.8               | 6048                     |
|            | ABS-C3-3    | 28.5               | 2.1             | 29.3               | 43.4            | 1.7               | 6050                     |

From tables 1, 2 and 3 the comparison of the average coal quality between the pit and stockpile can be seen in the change in coal content in the two varied locations. It is shown by the higher quality position in the stockpile compared to the quality in the mining pit. That is, there is a change in content starting from the water content (total moisture), ash content, content of flying substances (volatile matter), fixed carbon content and total sulfur content, while the calorific value has decreased quality [3]. Seen from the results of the average quality of coal from all parameters underwent changes, the change that was very dominating of the quality in both locations was ash content and total sulfur content.

On layer 1 (coal with 10 cm clay insert thickness), the ash content difference in the pit and stockpile is 1.6%, while the difference in total sulfur content in the pit and stockpile is 0.7%. For layer 2 (coal with a thickness of 20 cm clay insert), the difference in ash content in pits and stockpiles is 1.5%, while the difference in total sulfur content in pits and stockpiles is 0.7%. As for layer 3 (coal without clay parting) the difference in ash content in pits and stockpiles is 1.5%, while the difference in total sulfur content (total sulfur) in pits and stockpiles is 0.7%.

Addition of ash content comes from soil impurities (dilution) in the transition zone that was taken. Where the dilution is taken when stripping coal in the upper transition zone (between the over burden layer with coal), and the lower transition zone (between coal and inter burden). With the addition of dilution from mining, the ash content in the stockpile has increased.

3.2. Handling coal quality in the pit and stockpile

3.2.1. Preparation handling coal quality in the pit. Efforts that can be made in mining operations technically to get clean coal to include:

- Exposed coal must be free from mud contamination, loose overload material, topsoil/subsoil material, scoria and free face of coal must be all open.
- Clean the roof of the coal (cleaning roof) using an excavator that has bucket teeth. If the roof cleaning material is visually still a prospect taken, it can be turned into dirty coal which will later be processed into clean coal through the washing process at the washing plant [4].
- If there is a coal banded coal condition (layers of coal with many irregular parting inserts) that if it affects the quality, then the coal banded can be removed/dredged with the excavator earlier.
- If there is a parting layer > 7 cm in the coal, then the parting must be discarded and the coal under the parting > 7 cm must do another roof cleaning.
- If there is a parting layer ≤ 7 cm in the coal, then the parting can be combined with coal with the quality record of coal layers above and below the parting is the same. This is called a composite.
- If there is a parting layer ≤ 7 cm on the coal, then the parting must be discarded and the coal under the parting ≤ 7 cm must do another roof cleaning, with a note that the quality of the coal layers above and below the parting is different. This is called play. The composite is not done because the total quality will drop [5].
3.2.2. Preparation coal quality in the stockpile. Storage management or management of coal storage in stockpiles is crucial in stockpile management. In managing coal storage in a stockpile, things that need to be considered are the stockpile design and stacking system [6].

The design of a stockpile is determined by the following [7]:

- Coal storage capacity
- Many types of products will be separated in the stockpile
- Stacking and loading facilities and systems
- Coal Stockpile System

4. Conclusion

- The activity of monitoring the quality of coal from the pit to the stockpile can be doing by making checks at the two locations including taking samples in the pit over three parts, namely the first part, layer one and layer two, while in the stockpile separation of piles is done for each - each coal stripping layer (between layer one, layer two and layer three).
- From several parameters that have changed, visible ash content and total sulfur content has a dominating change.
- Efforts to mitigate changes in the quality of coal from mining are the implementation of selective mining operations with supervision from all divisions in the company related to mining operations.

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