

Engineering Evaluation of Self-Combustion Prevention and Stockpile Management Optimization at PT. Kuansing Inti Makmur

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ABSTRACT

This study looks into the thermal risks and ways to deal with them that come with coal self-combustion at the Alam Barajo stockpile, which is run by PT. Kuansing Inti Makmur. Three coal piles: UHS 12F (± 2 months), UHS 01A (± 1 month), and Medium 11C (± 3 months), were monitored to see how the length of time they were stored and how often it rained affected the temperature rise and the subsequent quality loss. The results reveal that the temperature of the pile rises dramatically with extended storage. For example, UHS 12F had a daily rise of 5.04°C, while UHS 01A saw a rise of 1.65°C. Self-combustion in Medium 11C reached a high of 222.1°C, which caused the ash content to rise by 2.62% and the calorific value to drop. Heavy rain made the temperatures drop for a short time, which suggests that evaporative processes caused the cooling. The study shows that present ways of managing stockpiles, especially the FIFO technique, are not being used to their full potential. To reduce the risk of combustion and keep the quality of the coal, engineers advocate making changes like regular temperature monitoring, correct compaction, covering with tarps, and distributing the coal before it catches fire.

Keywords

coal stockpile, self-combustion, temperature monitoring, ash content, thermal danger and safety in the workplace

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INTRODUCTION

Several mining policies discuss occupational safety. The first policy is Law No. 3 of 2020 and ESDM Regulation No. 28 of 2009, there are several stages in coal mining, including general investigation, exploration, feasibility study, construction, mining, processing, and post-mining reclamation. Next is Government Regulation of the Republic of Indonesia No. 55 of 2010. This regulation is the legal basis for the importance of creating good, sustainable mining governance that is in favor of national interests and the wider community. This regulation emphasizes that guidance and supervision are not only the responsibility of the central government, but also the provincial and district/city governments according to their authority. In addition, the company must also participate in coal supervision and stockpiling activities, the amount of coal and quality, so that the quality of the coal is maintained.

ESDM Ministerial Regulation 26 of 2018 concerning the implementation of good mining principles and supervision of MINERBA mining and ESDM Ministerial Decree 1827 K 30 of 2018 concerning guidelines for the implementation of good mining engineering principles are the main foundations for the implementation of good mining practices in Indonesia, which emphasize the importance of technical aspects, safety, environment, conservation, governance, and strict supervision so that mineral and coal mining activities run professionally, safely, environmentally friendly, and provide optimal benefits for the state and society. In addition, the Decree of the Director General of MINERBA KESDM No. 185.K / 37.04 / DJB / 2019 contains technical guidelines that must be followed by holders of IUP, IUPK, IUP Production Operations specifically for Processing and / or Refining, and IPR in implementing mineral and coal mining safety. Furthermore, the 2018 SMKPLH Policy prepared by PT Kuansing Inti Makmur contains the implementation of the national standard for the Mineral and Coal Mining Safety Management System (SMKP Minerba) which integrates aspects of occupational safety and environmental protection. This policy aims to create safe, healthy, and environmentally friendly mining operations by implementing the principles of planning, implementation, supervision, and continuous improvement. The description of several government regulations can be seen that the safety and environmental aspects of mining are very important. Smoke from burning in stockpile contains carbon dioxide (CO₂), Sulfur dioxide (SO₂) and Nitrogen dioxide (NO₂). Carbon dioxide (CO₂) is a colorless, odorless, non-flammable, and slightly acidic liquid gas. CO₂ is heavier than air and dissolves in water. The effect of carbon dioxide is to pollute the air which interferes with breathing and causes shortness of breath. Sulfur dioxide (SO₂) is a colorless gas and has a pungent odor. The effect of this sulfur dioxide is to irritate the eyes, throat, and respiratory tract. Short-term exposure can cause eye burns, coughing, and shortness of breath. Nitrogen dioxide (NO₂) is a toxic gas, brown-red in color. The formation of nitrogen oxides occurs in the combustion of coal, oil, natural gas, and so on. NO₂ can be harmful to humans and the environment, the effects of which include damaging the lungs and polluting the air which interferes with breathing [1].

Maintaining coal quality during storage in *stockpiles* is one of the challenges in mining operations, especially related to the risk of self-combustion. Coal *stockpiles* are the first coal storage places to enter after undergoing a long transportation process from distributors or from material excavation sites in the mining industry. The handling of coal entering *the stockpile for the first time* is the process of maintenance, control and maintaining the quality of the coal so that it remains stable in order to meet coal quality requirements. Handling of this *stockpile* aims to prevent self-combustion [1], [2].

Spontaneous combustion *is* the process of coal burning itself due to an exothermic oxidation reaction that causes an increase in temperature [3]. Coal exposed on the surface due to mining activities or coal piled in *stockpiles* will undergo an oxidation process. If this oxidation process occurs continuously, it will result in an increase in temperature. So that the temperature in the stockpile will accumulate and rise to the combustion point temperature (*self combustion*) which results in *spontaneous combustion* [4]. In addition, one of the factors that can cause an increase in coal temperature in *the stockpile* is the calorific quality of the coal. Where the results of the proximate and ultimate analysis determine the rate of coal spontaneous combustion. The mitigation process of improving coal quality is needed to reduce the impact of spontaneous combustion in *the stockpile* . [5].

Some steps that can be taken to prevent spontaneous combustion are to routinely check the *stockpile* temperature using a tool. *Thermocouple* . If the temperature reach 50°C-60°C, then handling will be carried out such as *spreading* , *stockpile* compaction and others [6]. Compaction is the process of compacting stockpiles with the aim of reducing the space between coal grains so that the gaps that can be filled with oxygen become smaller or fewer [7]. By narrowing the

oxygen space that enters the stockpile, the coal oxidation process that causes self - *heating* and finally spontaneous combustion (self-ignition) can be minimized. The storage time of coal also greatly affects the occurrence of self-ignition. The longer the coal is stored, the greater the possibility of a decrease in its quality. Therefore, it is advisable not to store more coal than necessary and to maintain a fast rotation in the storage and use process [8], [9].

stockpile management , such as the length of coal storage and compaction methods in the ROM *stockpile* . Poor *stockpile* management includes not using the basic principles of *stockpile management* , namely the application of the FIFO (First In First Out) system [10], [11]. Coal storage regulation is important because it is related to maintaining the quantity and quality of coal stock. Storage management begins with good storage planning and aims to maintain quantity, quality and the environment. Storage management emphasizes quantitative maintenance because it is important to consider the amount of storage capacity that can be maximized in the available space, but must always consider quality and environmental factors [12].

This problem was found in the Alam Barajo *stockpile* owned by PT. Kuansing Inti Makmur, a coal mining company located in Muara Bungo Regency, Jambi. The UHS 12F, UHS 01A, and Medium 11C stockpiles are some of the stockpiles that have shown indications of *self-combustion* in February 2025. Even in the Medium 11C stockpile, there has been a spontaneous combustion. This problem occurs due to irregular temperature control and the implementation of a less effective FIFO (*First in First Out*) stockpiling system, caused by an imbalance between incoming and outgoing coal.

To minimize losses, maintain coal quality, and reduce environmental impacts, this study aims to examine the management of self-combustion handling in PT. Kuansing Inti Makmur stockpile. It is expected that efficient prevention solutions can be found through increased temperature monitoring and improved stockpile management.

METHOD

Research Type

This study is categorized as applied research, aimed at addressing practical issues related to self-combustion in coal stockpiles. The focus is on applying scientific knowledge to develop actionable solutions, particularly within the context of mining operations.

Research Stages

The research stages carried out in this study are:

1. Collection of literature studies from books, scientific journals, and *online sources* related to coal, *stockpiles* , and *self-combustion* .
2. Field observations to assess the feasibility of the research location.
3. Data collection,
 - a. Primary Data
Daily temperature measurements were conducted on UHS 12F, UHS 01A, and Medium 11C stockpiles for 7 days. Observations of *stockpile conditions* , namely stockpiling methods, drainage systems, and contamination.
 - b. Secondary Data
Secondary data consists of coal quality parameter data (TM, AC, CV, VM) obtained from PT. Kuansing Inti Makmur and rainfall data during the research period.
4. Data processing
Data processing in this study was carried out in several stages, namely:
 - a. Analysis of the effect of stacking time on coal temperature.

- b. Analysis of the effect of rainfall on coal temperature.
- c. Analysis of the impact of self combustion on coal quality.
- 5. Data analysis
 - a. Comparison of temperature measurement results and coal quality parameters before and after self combustion.
 - b. Evaluation of triggering factors for *self-combustion* and recommendations for handling it.

Research Flow Chart

The research workflow includes a systematic sequence: literature review, data collection (primary and secondary), data processing, data analysis, and finally, formulation of conclusions and practical recommendations. A flowchart illustrating this process is presented in Figure 1.

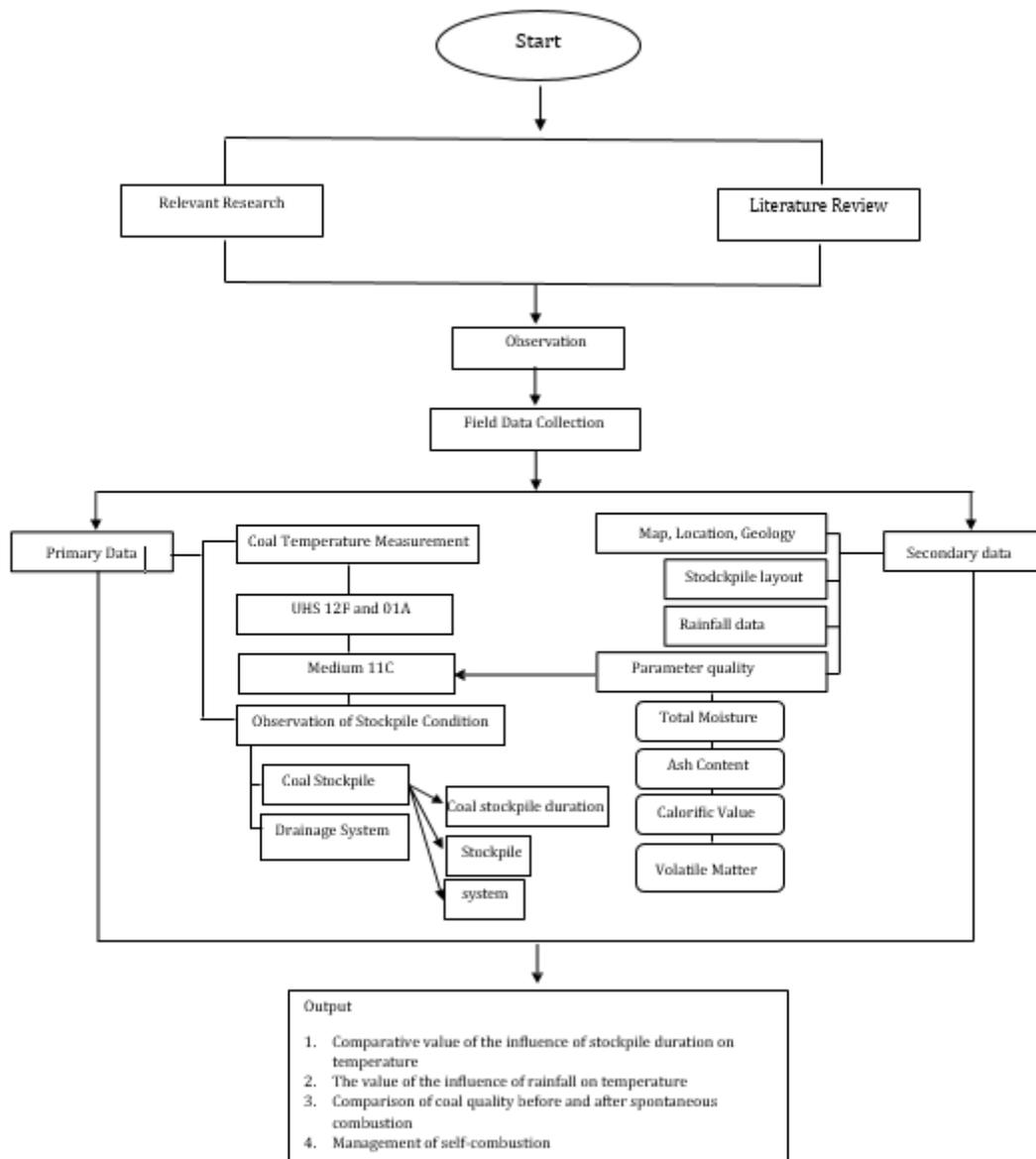


Figure 1. Research Flowchart

The results of this investigation should provide us a full picture of how coal behaves thermally in stockpiles under different situations. The study's main goal is to give a numerical answer to the question of how stockpile age and rainfall affect changes in coal temperature. There will also be a comparison study to look at how the quality of coal changes, such as its ash content, moisture, and calorific value, before and after it catches fire on its own. Based on these results, the study will provide technical ways to better handle and lower the danger of spontaneous combustion in stockpile operations in the future. Overall, the research should make a big difference in how stockpiles are managed and make large-scale coal mining operations safer and more efficient.

RESULT AND DISCUSSION

Stockpile Condition at PT. Kuansing Inti Makmur

Stockpile System, PT. Kuansing Inti Makmur uses an open system stockpile (Alam Barajo stockpile) with a combination of chevron and truncated pyramid patterns. Piling is done back and forth until it reaches a certain height using excavators and wheel loaders. Stockpile Height, UHS 12F: 9 m (exceeds the standard, risk of self-combustion). UHS 01A: 5 m (according to standard). Medium 11C: 10 m (exceeds the standard, risk of self-combustion and landslides). Stockpiles that are too high can increase heat absorption and slope instability. Stockpile Slope Angle, Safe angle: 38° (angle of coal repose). UHS 12F: 37.9° (almost ideal). UHS 01A: 29° (below standard). Medium 11C: 38° (ideal). Inappropriate slope angles can affect wind flow and the risk of self-combustion. Drainage System The drainage system is not yet effective because the height of the drainage channel is the same as the ground floor of the stockpile. Water pooling around the stockpile accelerates evaporation and traps heat, increasing the risk of self-combustion. Stockpile temperature and rainfall measurements were conducted for 7 days (11–17 February 2025) at 4 points (north, west, south, east) on stockpiles UHS 12F, UHS 01A, and Medium 11C.

UHS 12F Stockpile

Effect of Storage Duration on UHS 12F Coal Temperature

The UHS 12F stockpile has been in storage since December 2024, which is around two months. To make sure the data was consistent during the observation period, tape was used to clearly indicate the temperature measurement sites. Figure 2 shows how the measuring sites are laid out in the UHS 12F stockpile

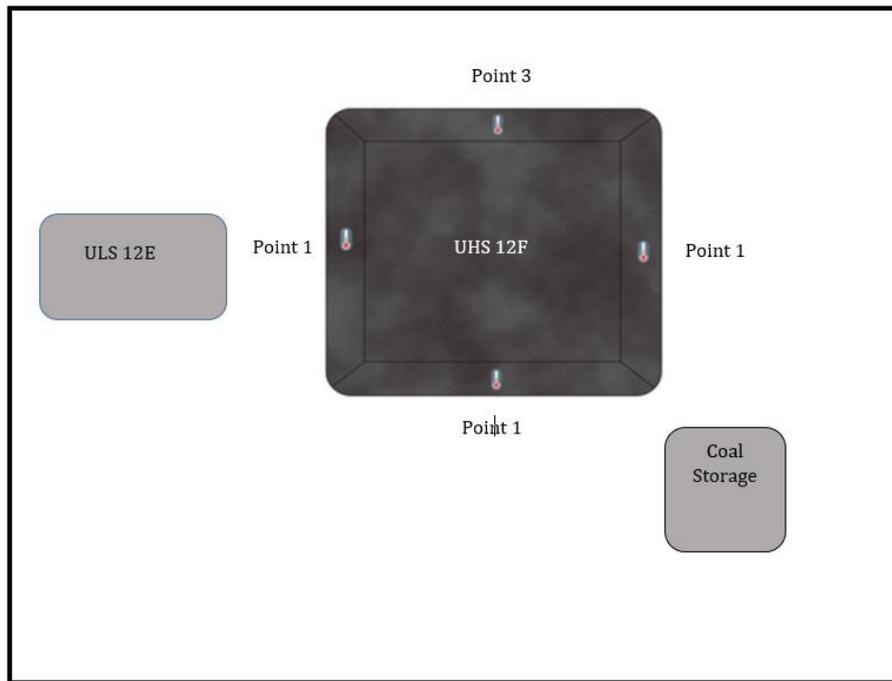


Figure 2. Location of temperature measurement points at stockpile UHS 12F

Table 1. Table of results of temperature and rainfall measurements on the UHS 12F stack.

No	Date	Point 1	Point 2	Point 3	Point 4	Rainfall
1	February 11, 2025	35.6 °C	40.5 °C	50.2 °C	53.2 °C	0.0 mm
2	February 12, 2025	30.5 °C	39.1 °C	56.1 °C	40.3 °C	0.2mm
3	February 13, 2025	39.5 °C	38.3 °C	60.7 °C	40.5 °C	5.5mm
4	February 14, 2025	41.1 °C	53.0 °C	61.5 °C	45.5 °C	12.0mm
5	February 15, 2025	52.5 °C	50.0 °C	51.6 °C	45.7 °C	1.5mm
6	February 16, 2025	58.4 °C	55.1 °C	49.3 °C	46.2 °C	1.0mm
7	February 17, 2025	65.8 °C	64.6 °C	59.7 °C	44.2 °C	52.0 mm

The graph of the effect of stockpile length on UHS 12F coal temperature in February 2025 can be seen in Figure 3.

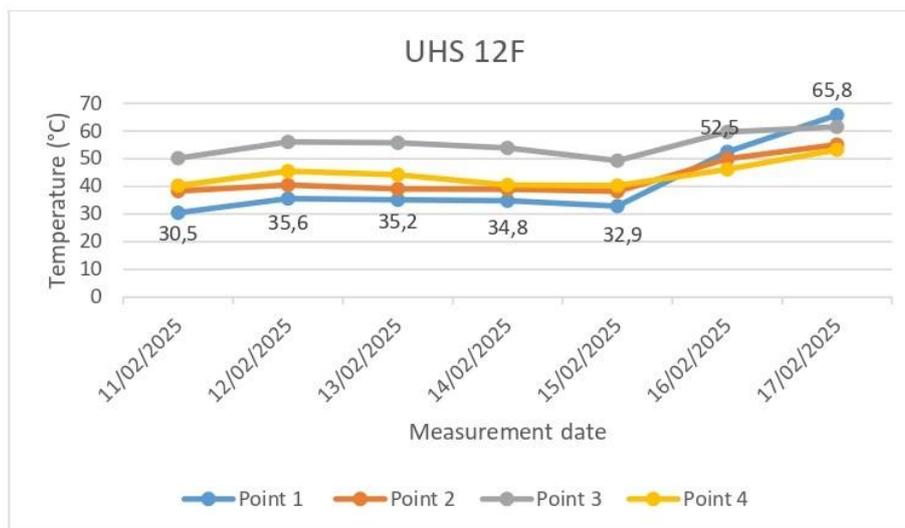


Figure 3. Graph of the effect of stockpile duration on coal temperature at UHS 12F

From the Figure 3, it can be seen that the longer the stockpile is left, the temperature on the stockpile continues to rise.

Analysis of the Effect of Rainfall on the Temperature of UHS 12F Stockpile

In the stockpile, a comparative analysis between coal temperature and rainfall was also carried out. The results of the comparison can be seen in Figure 4.

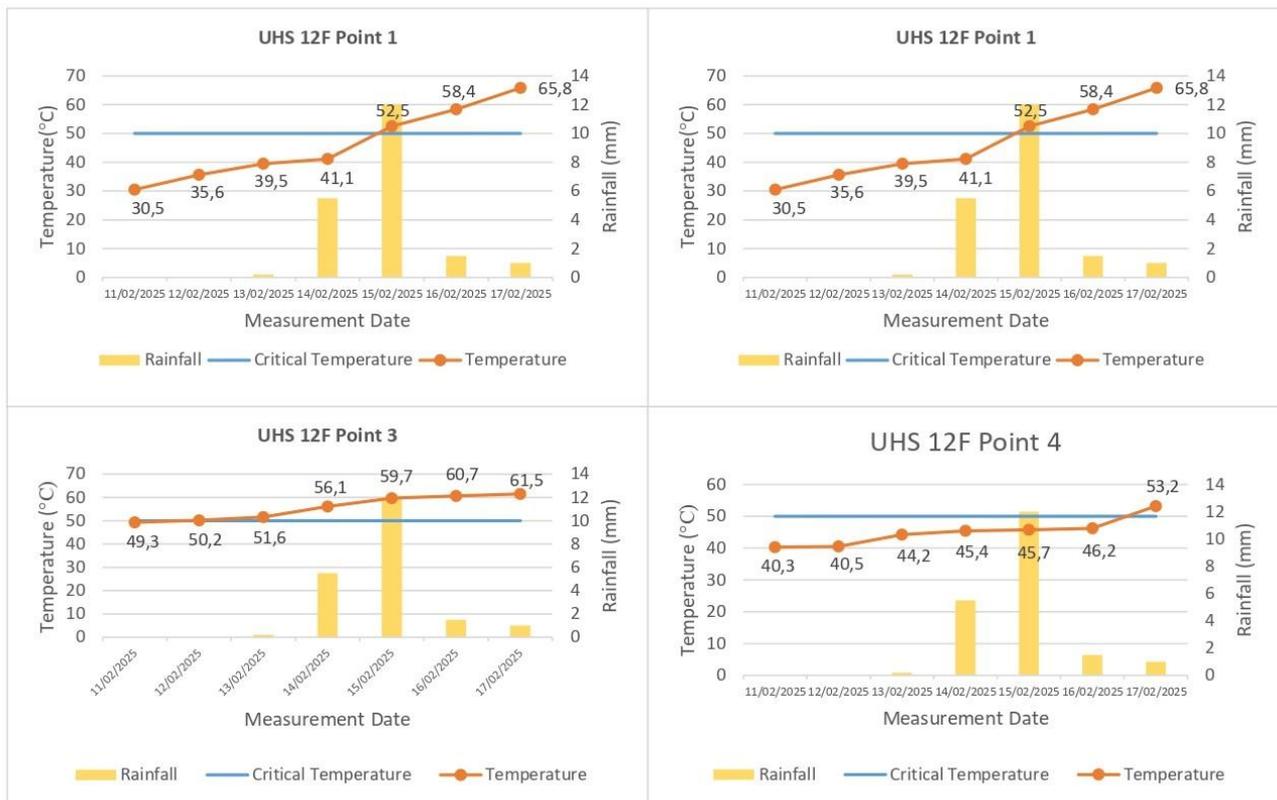


Figure 4. Graph of the effect of rainfall on the temperature of UHS 12F coal at points 1, 2, 3 and 4.

The graph shows that the temperature of the coal rose steadily as it was stored for longer periods of time. But when the rain got heavier, the temperature started to drop. The coal temperature was at its lowest when it was raining the most. After that, the temperature started to increase again as the rain stopped. This happens because precipitation gets into the coal's pores, which starts an evaporation process that takes in latent heat and cools the stockpile for a short time. After the rain stopped, evaporation kept going, which made the air cooler. But after this effect, heat slowly built up because oxidation reactions were still happening in the coal mass.

UHS 01A Stockpile

Analysis of the Effect of Stockpile Duration on UHS 01A Coal Temperature

The age of the UHS 01A stockpile ± 1 month. The location of the measurement point in *the stockpile* can be seen in Figure 5.

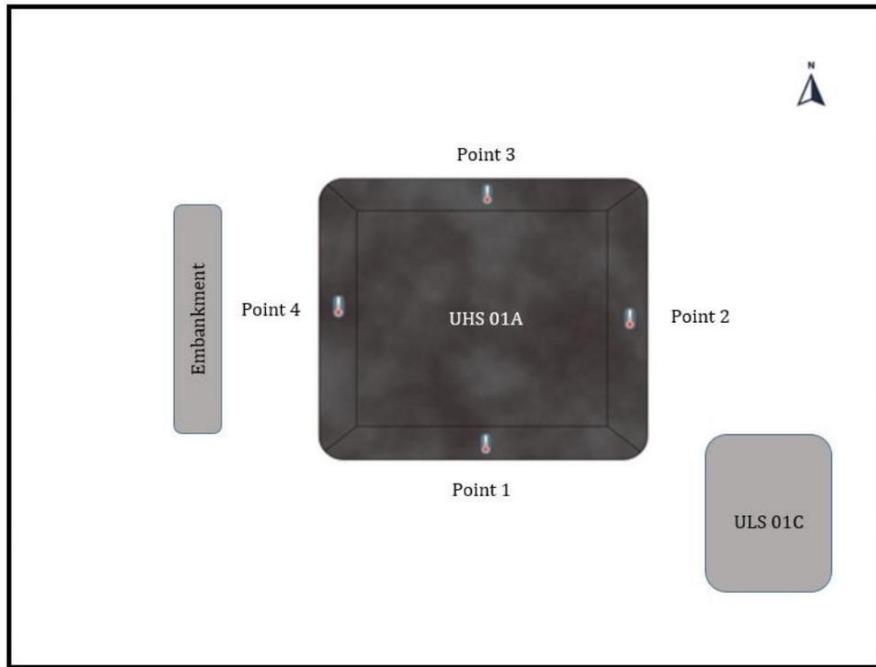


Figure 5. Location of temperature measurement points at stockpile UHS 01A

Table 2. Results of Temperature and Rainfall Measurements at Stockpile UHS 01A

No	Date	Point 1	Point 2	Point 3	Point 4	Rainfall
1	February 11, 2025	26.1 °C	26.5 °C	29.4 °C	27.5 °C	0.0 mm
2	February 12, 2025	26.1 °C	27.5 °C	29.3 °C	29.3 °C	0.2mm
3	February 13, 2025	26.3 °C	27.6 °C	31.4 °C	29.3 °C	5.5mm
4	February 14, 2025	25.3 °C	30.3 °C	30.5 °C	28.8 °C	12.0mm
5	February 15, 2025	24.4 °C	26.5 °C	31.8 °C	29.2 °C	1.5mm
6	February 16, 2025	26.5 °C	26.8 °C	34.1 °C	30.1 °C	1.0mm
7	February 17, 2025	24.6 °C	25.1 °C	34.0 °C	39.1 °C	52.0 mm

The graph of the effect of stack length on the temperature of UHS 01A coal in February 2025 can be seen in Figure 6.

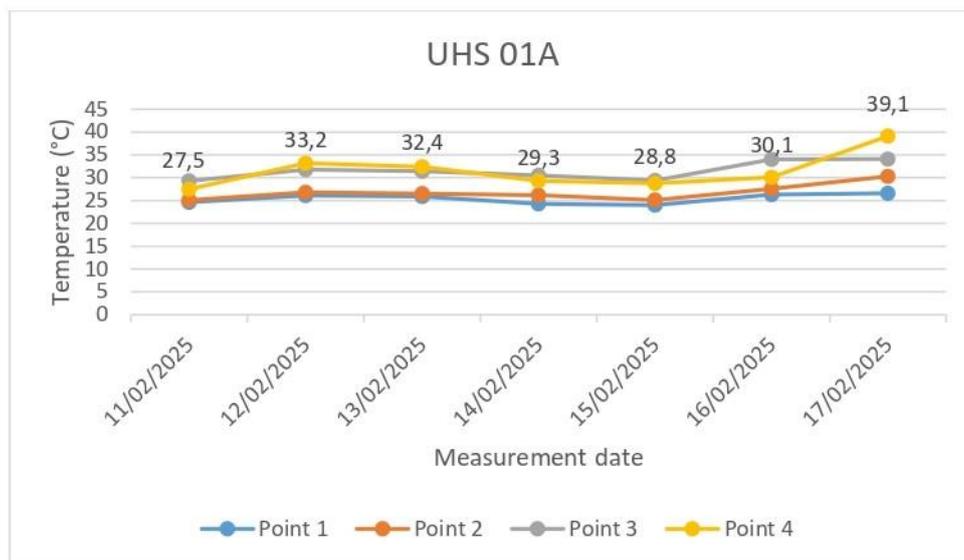


Figure 6. Graph of the effect of stockpile duration on coal temperature at UHS 01 A

From the graph in the Figure 6, it can be seen that the longer the stockpile is left, the temperature on the stockpile continues to rise.

Analysis of the Effect of Rainfall on the Temperature of UHS 01A Stockpile

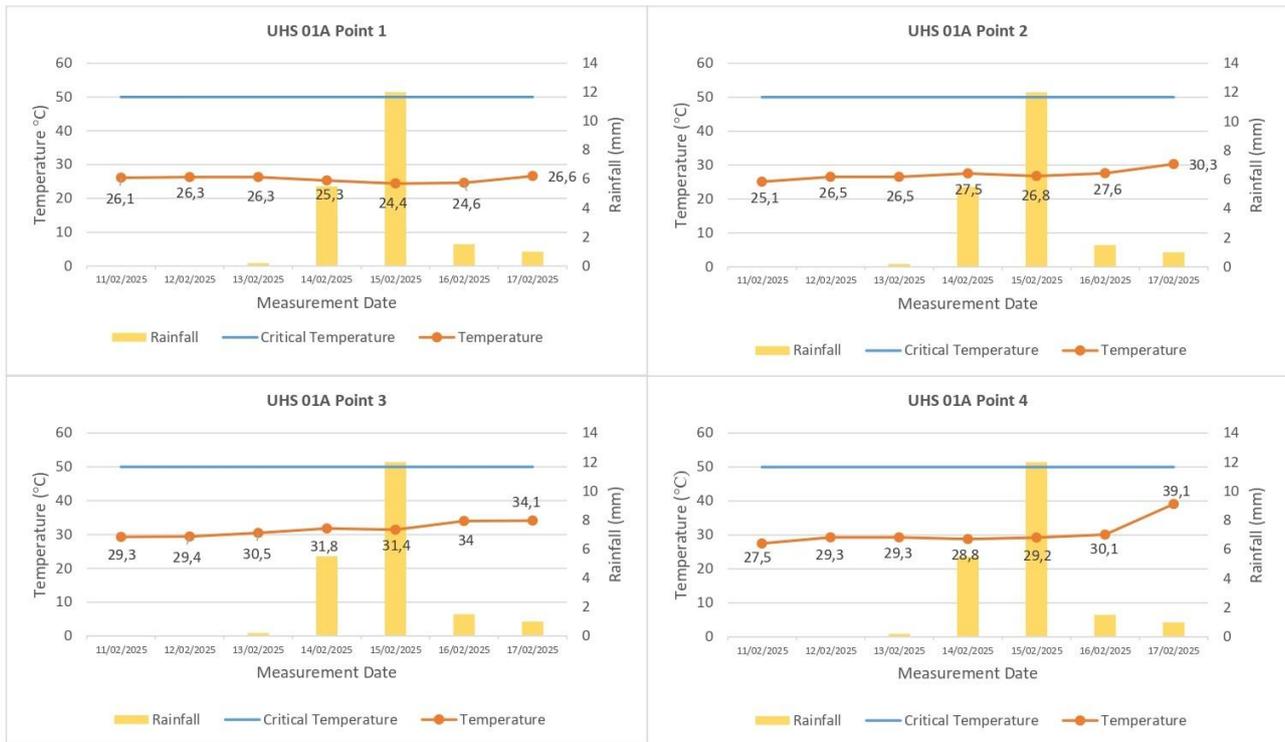


Figure 7. Graph of the effect of rainfall on the temperature of UHS 01A Coal at points 1, 2, 3 and 4.

The graph shows that the temperature rose steadily, which was directly related to how long the observation period was. As the rain got heavier, the temperature started to drop. The temperature dropped to its lowest point when it rained the most. After that, the temperature went up again when the rain stopped. This happened when rainwater got into the pores of the coal, starting an evaporation process that took in latent heat. When the rain stopped, evaporation kept going, which led to evaporative cooling. But this cooling effect was later followed by heat buildup because the coal kept oxidizing.

Medium 11C Stockpile

Analysis of the Effect of Stockpile Duration on Medium 11C Coal Temperature

The stockpile in Medium 11C had been there for around three months. Figure 8 shows where the temperature measuring stations were carefully placed in the stockpile.

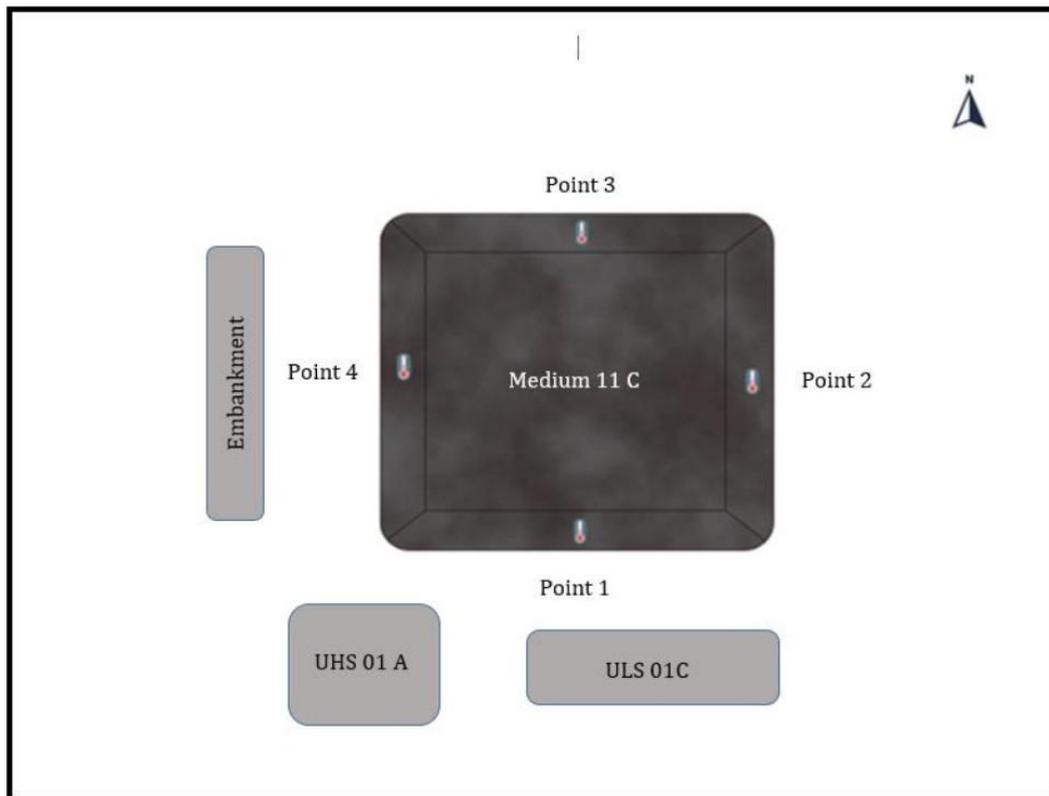


Figure 8. Location of temperature measurement points at Medium 11C

Table 3. Results of Temperature and Rainfall Measurements at Stockpile Medium 11C

No	Date	Point 1	Point 2	Point 3	Point 4	Rainfall
1	February 11, 2025	29.8 °C	32.05 °C	46.8 °C	32.3 °C	0.0 mm
2	February 12, 2025	34.7 °C	33.5 °C	37.9 °C	48.7 °C	0.2mm
3	February 13, 2025	34.9 °C	32.0 °C	59.0 °C	60.3 °C	5.5mm
4	February 14, 2025	34.8 °C	37.0 °C	51.7 °C	63.7 °C	12.0mm
5	February 15, 2025	39.1 C	37.5 °C	56.5 °C	222.1 °C	1.5mm
6	February 16, 2025	50.3 °C	47.5 °C	56.8 °C	63.1 °C	1.0mm
7	February 17, 2025	60.6 °C	42.8 °C	60.5 °C	51.5 °C	52.0 mm

The graph illustrating the effect of storage duration on coal temperature in the Medium 11C stockpile during February 2025 is presented in Figure 9.

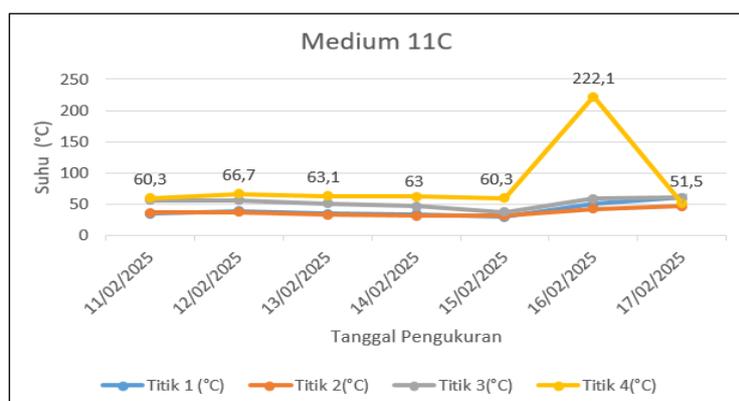


Figure 9. Graph of the effect of stacking time on medium coal temperature 11c

Figure 9 shows that the temperature rises over time the longer the coal is kept in storage. The highest temperature ever recorded was 222.10°C at Observation Point 4 on February 15, 2025. By that time, spontaneous combustion had already happened.

Analysis of the Effect of Rainfall on the Temperature of Medium 11C Stockpile

The results of the comparison of the effect of rainfall on coal temperature can be seen in Figure 10.

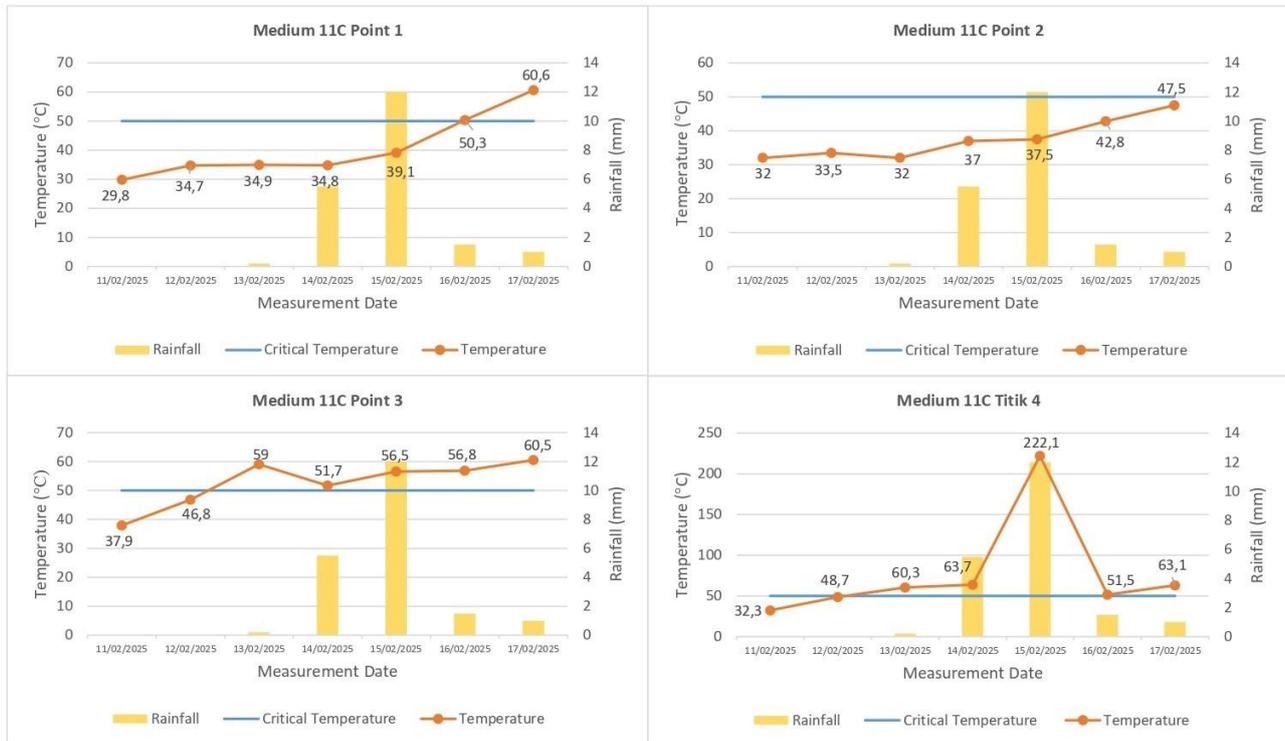


Figure 10. Graph of the effect of rainfall on the temperature of Medium 11C coal at points 1, 2, 3 and 4

The graph in the Figure 10, shows that the temperature of the coal slowly rose during the course of the observation period. When the rain got heavier, the temperature started to drop. The coal temperature dropped to its lowest point when it rained the most. The temperature began to increase again once the rain stopped. This happens because rainwater gets into the coal's pores, which causes evaporation that takes in latent heat. Evaporative cooling happened after the rain stopped because evaporation kept going. But afterward, heat built up because of oxidation reactions.

On the sixth day, Observation Point 4 saw a big jump in temperature, going up to 222.10°C. This was because the oxidation sped up when the rain fell from 12.0 mm to 1.5 mm. To lower the chance of burning and let the heat escape, an excavator spread the coal out to lower the risk of combustion.

Analysis of the Effect of Self-Combustion on Coal Quality in Medium 11C

Coal quality analysis was conducted on February 3, 2025 (before self-combustion) with coal quality on February 17 (after **self-combustion**). The Medium 11C stockpile was tested for total moisture, ash content, and calorific value, among other things. Table 4 shows the data on the quality of the coal, and Figure 11 shows how the quality has changed over time.

Table 4. Data parameter quality batubara

Measurement Date	TM (%)	AC (%)	CV (Kcal/Kg)	VM (%)
February 3, 2025	30.13	13.88	5289	34.66
February 17, 2025	29.08	16.50	5135	36.44

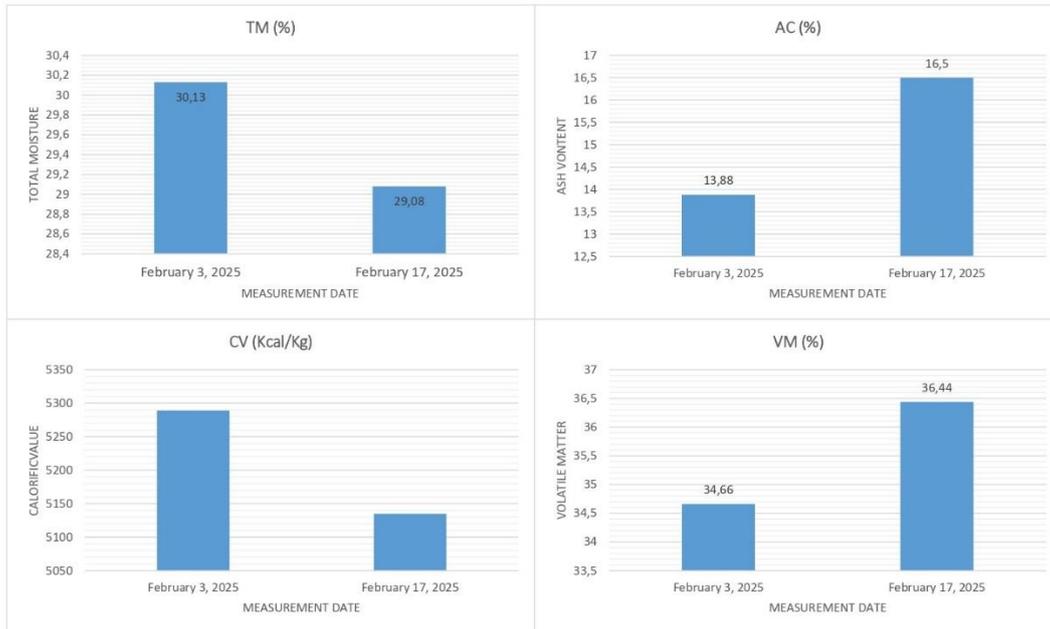


Figure 11. Graph of Changes in Coal Quality1

Coal Quality Change Analysis

Based on the analysis results of the Medium 11C stockpile, the total moisture content decreased from 30.13% to 29.08% over a 14-day period, showing a reduction of 1.05%. This decrease is attributed to the self-combustion process, during which water content was lost through evaporation due to elevated internal temperatures within the stockpile.

In terms of ash content, there was a significant increase from 13.88% to 16.50%, representing a rise of 2.62%. This increase is the result of partial combustion, which turned solid coal particles into ash. The residual ash subsequently mixed with surrounding coal, producing fine coal particles that act as contaminants during combustion analysis, thereby lowering overall fuel quality.

The calorific value of the Medium 11C coal also declined, from 5289 kcal/kg to 5135 kcal/kg, mainly due to the increased ash content caused by the self-combustion. Additionally, volatile matter content increased from 34.65% to 36.44%, a difference of 1.78%. This change is associated with rapid oxidation of volatile matter compounds, which generate heat and contribute to spontaneous ignition, particularly due to the presence of highly flammable gases within the volatile fraction.

Self-Combustion Management at PT. Kuansing Inti Makmur

Implementation of FIFO Management

PT. Kuansing Inti Makmur has implemented the First In, First Out (FIFO) system at its coal stockpile, whereby coal that is dumped first is prioritized for loading. However, the FIFO system was not effectively applied in practice due to variations in coal quality that limited its consistent use. Table 4 presents FIFO data for the Medium 11C stockpile.

Table 4. FIFO data of Medium 11C coal stack

Date	Initial stock	Delivery out	Remaining stock
10/02/2025	118,000	2,159.82	115,840.82
11/02/2025		3,291.82	112,548.18
12/02/2025		2,971.98	109,576.2
02/13/2025		2,473.51	107,099.69
02/14/2025		2,766.60	104,333.09
02/15/2025		3,471.78	100,861.31
02/16/2025		2,377.12	98,484.19
02/17/2025		3,236.27	95,247.92

Stock Out = 2,159.82 + 3,291.82 + 2,971.98 + 2,473.51 + 2,766.60 + 3,471.78 + 2,377.12 + 3,236.27 = 22,748.90 tons

$$\text{Mean} = \frac{\text{Issued Stock}}{\text{Total Days}} = \frac{22,748,90 \text{ tons}}{8} = 2,843,61$$

$$\text{Coal Inventory Balance} = 118,000 \text{ tons} - 22,748,90 \text{ tons} = 95,247,92$$

$$\text{Coal Stock Duration} = \frac{\text{Stock Left}}{\text{Mean}} = \frac{95,247,92}{2,843,61} = 33,49 \text{ days} = 34 \text{ days}$$

The estimates showed that the coal stockpile would run out in 34 days. But after just eight days, the Medium 11C stockpile caught fire on its own. This difference shows that PT. Kuansing Inti Makmur's FIFO (First In, First Out) system isn't working properly. The idea behind FIFO is to lower the risk of spontaneous combustion by sending out older coal before newer coal. But in actual life, this idea hasn't been fully realized.

Spreading to Reduce Coal Temperature

One way that PT. Kuansing Inti Makmur stops self-combustion is by spreading, which means moving coal around in places where it is starting to catch fire. The goal of this technique is to get rid of internal hotspots and lower the coal's temperature below important levels. Heavy equipment like excavators is used to spread, as seen in Figure 12.



Figure 12. Spreadingn Process

Covering Stockpiles with Tarpaulin (Tarping)

Another way to stop fires from happening is to cover coal stacks with tarps. The main goal of tarping is to keep rainfall from getting into the coal, which could speed up oxidation and raise the internal temperature, both of which are important elements in self-combustion. Tarping

also keeps coal from coming into direct touch with oxygen in the air, which slows down the rate at which it heats up within.

Field observations showed that heaps covered with tarps had a much reduced danger of catching fire on their own when it rained than ones that weren't covered. This means that tarping is a useful and effective way to stop anything from happening, especially if it is done uniformly throughout all storage units.



Figure 13. Tarping Process

Operational Control Procedure (PPO) of PT Kuansing Inti Makmur

Compaction

If a certain part of a stockpile is hotter than 60°C or makes visible white steam, a wheel loader should be used to compact it. This will keep oxygen from getting in and keep the temperature under control

Watering Spraying

If flames are found in a stockpile, water spraying must be used until the fire is completely out. When the temperature goes below 60°C, the burnt coal that can't be sold (ash) should be separated and thrown away. The rest of the coal that can be sold should be refilled and compacted (the trimming process).

Investigation

The refilled stockpile should be looked at or checked out. There will be an official report that shows what happened during this test.

Discussion

The results of this study show that there are several important things that affect the likelihood of spontaneous combustion in coal stockpiles. The length of time that coal is stored is one of the most important factors. It was clear from the observations that longer storage times led to bigger temperature rises. For example, UHS 12F, which had been held for around two months, had a daily temperature rise of 5.04°C. This was far higher than the 1.65°C rise seen in UHS 01A, which had only been stored for one month. The temperature of the Medium 11C stockpile, which had been held for about three months, rose dramatically to 222.1°C, which confirmed that spontaneous combustion had begun.

Another important result is that rain has an effect, acting as a temporary cooling agent. When it rained a lot, the temperature of the coal dropped because the rainwater absorbed latent

heat and then cooled down by evaporating. But this impact didn't last long, since temperatures started to rise again when there was less rain, which meant that oxidative reactions were back.

The combustion event in Medium 11C had a big effect on the quality of the coal. The ash content went up by 2.62%, and the calorific value was down by the same amount because of leftover mineral contamination. The volatile matter also went up by 1.78%, which suggests that combustible gasses were building up, which increased the risk of self-heating and combustion.

There were several attempts to use self-combustion mitigation measures in the field, like FIFO, spreading, and tarping, however these efforts didn't entirely follow the company's Operational Control Procedures (OCP). There is a gap between policy and practice since the suggested actions, such as compaction, water spraying, and post-event inquiry, are not always followed. This difference shows how important it is to do thorough evaluations and make sure that procedures are followed more closely in order to make stockpiles safer and more reliable.

CONCLUSION

This study finds that the length of time coal is stored has a big effect on the temperature of the stockpile. Longer storage times are linked to bigger daily temperature rises. UHS 12F and UHS 01A, which were stored for about two and one months, respectively, showed different thermal behavior. The Medium 11C stockpile, which was stored for three months, had a critical temperature rise that caused it to catch fire on the sixth day of observation at 222.1°C.

The study also showed that rain momentarily lowers the temperature, but after the rain stops, the coal heats up again because of internal oxidation processes. Also, self-combustion makes coal much worse by increasing the amount of ash and volatile materials and lowering the calorific value. This makes it even more dangerous to handle and use.

PT. Kuansing Inti Makmur has used different ways to reduce risk, such as FIFO management, spreading, and tarping. However, these steps did not entirely follow the company's Operational Control Procedure. So, to make sure that self-combustion occurrences in coal stockpiles are managed more effectively, consistently, and preventively, field practice and formal guidelines need to be thoroughly reviewed and brought into line with each other.

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