# BEHAVIOUR OF LOW RANK HIGH MOISTURE COAL IN LARGE STOCKPILE UNDER AMBIENT CONDITIONS

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## ABSTRACT

The low rank high moisture of coal from East Kalimantan, Indonesia has been tested in large stockpiles to understand the possibilities of lowering their total moisture content under ambient conditions. The results from the small scale drying tests indicate a strong potential to significantly reduce the "as mined" moisture content of high moisture low rank coal. All tests showed consistent losses over time with an average weight loss of 27% for the 22 day test period. These test show the maximum possible natural drying potential with no impediments to drainage and no additional moisture load from rainfall. It can be expected that drainage will allow reduction in moisture.

The size distribution shows a mean size of 10mm and low proportions of ultra-fine material, which makes the crushed coal suitable for stockpile drainage as there should be ample clearance between particles. Dry conditions allowed the piles to drain free moisture at a loss rate of between 0.7 and 1.7% per day. Additional rain periods ensured that the overall effect was a gain in moisture for the trial period. It would be apparent that the greatest drying benefit would be gained by sheltering the coal from rain. Any drying benefits gained by stockpiling could be reversed by rainfall exposure. This evaluation would suggest that, without consideration for the weather condition effecting the stockpile temperature and moisture, a natural drainage period of between 18 and 25 days would assist in the reduction of moisture associated with the high moisture low rank coal.

## KEYWORDS

Low rank, Coal, Stockpile, Total Moisture, Rainfall, Rain

## INTRODUCTION

Coal resources in Indonesia are classified mostly as lignite (58%) and the rest are sub-bituminous (27%), bituminous (14%) and anthracite (<1%). In the last 10 years, Indonesian coal production rose sharply, with increasing amount of coal produced being exported worldwide. Current coal production comes from medium to high rank coals, which have relatively high calorific value. However, the reserves of this range of coals are limited and with diminishing reserves, they will become increasingly expensive to mine. Low grade coals, which are mainly lignite and low grade sub-bituminous, constitute over 85% of the coal reserves. Indonesian low grade coals although are of high moisture in nature but have advantages of low sulphur and very low ash making their suitability as thermal coal.

Recent increase in utilization of high-moisture low rank coals following oil price rise has necessitated understanding overall aspects of coal storage and transport especially in humid and high ambient temperature conditions. Numerous literatures are published focusing the spontaneous combustion characteristic of coal in stockpile conditions. Moisture plays an important role on behavior of coals in stockpiles.

The complex processes of self- heating in the existence of water have been investigated by many workers [1-4]. It has been reported that low rank coals undergo the highest heating rate when their moisture content is reduced to about one-third of the original as-received moisture content [5]. Large scale stockpile test work was carried out by [6-7] mostly to understand self-combustion process. It is generally accepted that there are competing influences of heat of wetting and moisture evaporation depending on the environmental circumstances of the coal [8-10]. Numerical model studies by Akgun and Essenhigh [11] showed that moisture effects on self-heating in a broken coal stockpile situation are twofold. In the case of low moisture content coals, the maximum temperature increases steadily with time.

In the case of high moisture coals, temperature increases rapidly initially before evaporation dominates and the temperature reaches a plateau value (generally around 80-900C). Once the coal becomes dry locally the temperature will increase rapidly towards thermal runaway. However, if the coal stockpile has been in a prolonged drying phase that is interrupted by a rain event and the water penetrates into the stockpile then additional heat can be generated from the heat of wetting effect as the coal re-adsorbs the moisture available to it. This effect can also lead to premature thermal runaway in the coal pile. Curran et al [12] experimented coal stockpile with rain water system: (i) to determine the relative proportions of rain water and particulate matter associated with coal stockpile surface runoff, infiltration and internal storage; (ii) to determine coal-stockpile runoff rates associated with surface runoff and infiltration; and (iii) to determine the size and structural properties of particulate matter removed from the coal-stockpile system.

The deterioration was more prominent in sunny days with intermittent rain. Annually approximately 2500 kJ per kg decrease in calorific value of coal was observed [13]. The liability of spontaneous combustion of Turkish lignite was increased with decreasing particle size, increasing moisture content of the coal and decreasing humidity of the air [14]. The roles of bed porosity, side slope, wind velocity, coal reactivity and bed particle size are examined in detail for Wyoming subbituminous coal [15]. Petrographic analysis of Turkish coals showed that the coal sample having the highest inertinite group macerals was oxidized more easily, thus, yielding more CO2 and CO. Relatively higher rank coals were oxidized more easily, but oxidation diminishes with time. On the contrary, oxidation progresses with time for lower rank samples especially at relatively higher temperatures [16].

The influence of stockpile height, slope angle of bed, particle diameter of coal, and coal moisture content on spontaneous heating of coal stockpile was investigated [17]. Different degrees of compaction can be achieved and airflow rate varied to study the effects of varying rates of air permeation on the coal oxidation process. It has been found that inflow of air or oxygen into the stockpile is indispensable for durability of coal oxidation and heat accumulation inside the stockpile induces temperature rise over the critical value of about 200 °C. These two conditions for spontaneous ignition are met most in the edge of the stockpile [18].

The Coal Stock Stockpile Simulator (CSPS) serves as a simulation model which provides “what-if” scenarios and is forward looking. It can provide scenario planning sets for decision making [19]. The CSPS has demonstrated its value at various stages of piloting especially in contributing to the plans of the new generation of coal fired plant in South Africa. In the Australian and New Zealand coal industries there is one test that is routinely used the R70 self-heating rate test [20], which has been used to show the effects on coal self-heating rate of rank [21], type [22], mineral matter [23] and moisture [24].

The behavior of coal in a stockpile can be broadly grouped under three headings; examination of chemical constituents of coal, oxygen avidity studies and thermal studies. In chemical composition of coal, attempts have been made to determine the spontaneous heating tendencies of coal based on their constituents obtained from proximate and ultimate analyses. The maceral composition of coals and their susceptibility to spontaneous heating have led to the development of petrological classifications. The oxygen avidity studies include; proxy complex analysis rate study, Russian U-index and other oxidation methods. In thermal studies, different methods are attempted, which include; initial temperature, crossing and ignition point temperature, modified crossing point temperature, puff temperature, Olpinski index, adiabatic calorimetry, thermo-gravimetric (TG) analysis, differential thermal analysis (DTA) and differential scanning calorimetry. Spontaneous combustion of coal is influenced by the nature of the coal, particle size, geological condition and mining environment, all of which govern the thermal processes occurring in the coal.

In all the literatures the emphasis remained to evaluate the self-combustion behaviour of coal in a stockpile but to the best of authors’ information none of the literatures have aimed in utilizing the heat generated in stockpile for optimizing the total moisture in low rank high moisture coals to get the advantages on improving net heat value and transportability. The present paper focus on the impact of this oxidation process which increases the temperature of stockpile under ambient conditions, how can be best utilized for lowering the total moisture of low rank high moisture coals of Indonesia.

# EXPERIMENTAL

Extraction of coal was completed by opening a box cut. Mining was restricted to the top 10 meters of the approximately 20 meter thick seam. Run of Mine samples were sourced from the fresh working section of the exposed seam. Care was taken to collect ROM free of fines and in bigger sizes by striping. The mined coal was crushed, to a top size of 50 mm, by means of a two roll crusher fitted with a 50 mm grizzly screen in the feeder end.

The test plan was conducted in two ways –

*A) SMALL SCALE (50 KG):* The small scale test program provided an additional means to measure the maximum moisture loss of stacked coal over a period of time. To facilitate this, a series of samples (eight numbers) were placed within drainage bags and monitored regularly over a time period equaling that of the main stockpile tests. These tests were conducted under ideal drainage conditions, in a sheltered, covered laboratory situation. The measured weight loss is calculated as a moisture reduction and a moisture loss profile is established. Each bag was subjected to Free and Residual Moisture testing at a scheduled day. The weight loss profiles for bags are compared to provide additional information on reliability of data.

*B) LARGE STOCKPILE(500 TON):* two stockpiles

The crushed coal was loaded onto a prepared stockpile base area in two separate piles. The dimensional details of the test stock stockpile are shown in Table 1.

The primary objective of the test program was to measure the changes of stacked coal over a period of time in a larger stockpile under ambient conditions. To facilitate this, the series of samples were reclaimed, according to a predetermined sequence, then analyzed for changes in coal quality. Each sample was placed into a permeable woven polyester mesh bag designed to allow water flow but to contain crushed and pre-weighed quantity of coal. A lanyard attached to each bag, with an identification tag, was used to successfully extract the samples when required by the programs timetable. The bags were strategically positioned (Figure 1) to allow identification of moisture movements within the stock pile over the test period. The stockpiles were monitored for temperature and ambient weather conditions during the progress of the trial period. No provision was made to shelter the piles from rain or wind.

**Table 1: Final Stockpile Dimensions**

| | | |
|---|---:|---|
| Cone Angle | 118 | degrees |
| Radius | 9.5 | meters |
| Diameter | 19 | meters |

| | | |
|---|---|---|
| Height | 5.6 | meters |
| Angle of Repose | 30.5 | degrees |
| Bulk Density | 0.85 | $T/m^3$ |
| Volume | 530 | $m^3$ |
| Mass | 451 | Tonnes |
| Base Area | 59.73 | $m^2$ |
| | | |
| Rain load per mm | 0.06 | T |
| Rainfall | 163 | |
| Rain load per pile | 9.731 | T |
| Rain load per pile | 216.00 | % |

There are three levels of samples as shown. The bottom level (Layer Level 1) is approximately one meter above the stockpile base. The middle level (Layer Level 2) is designed at two and a half meters above the base. Layer Level 3 is set at four meters above the base. The three levels are designed to give an indication of the water movement horizontally over the testing period. All three levels have seven samples embedded at around one to one and a half meters from the final stockpile surface. Each of the seven samples in each level was evenly spaced around the pile. Once the stockpiles completed, each of the samples will be buried approximately one and a half to two meters from the external surface. There was an additional sample placed at the stockpile base prior to starting stockpile construction.

During construction of the piles, sample bags are weighed to the nearest 0.1kg and positioned by first leveling a bench in the partly completed pile. When all 23 samples are inserted, they were then covered with fresh crush coal till the final stockpile profile is complete. The program was set up for the two piles with sampling regimes offset by half a day. The recovered stockpile samples were double sealed in plastic bags and transported to Laboratory for Free and Residual Moisture analysis. On each day of the stockpile was monitored and stockpile conditions was recorded for rainfall, Humidity, Wind speed, Weather, Ambient temperature, stockpile temperatures, Digital photographs and collection of predefined samples and sending to laboratory with proper packing.

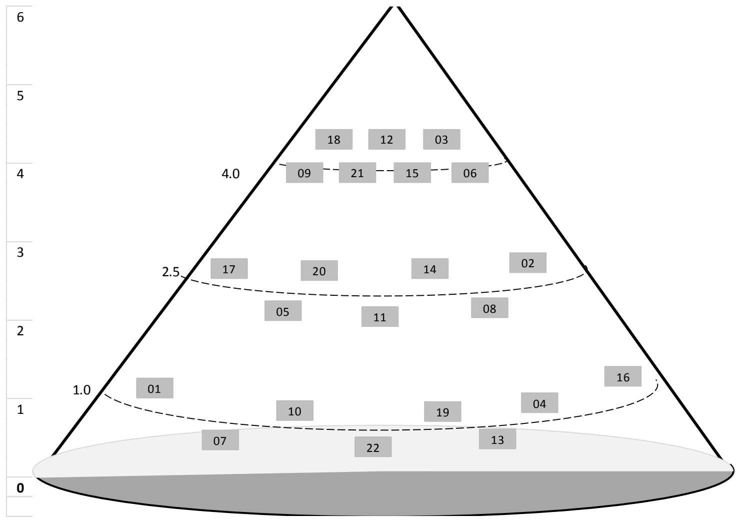



**Figure1: The embedded sample layout with the extraction sequence**

Representative composite fresh crushed sample was analyzed for Proximate Analysis, Granulometry, Equilibrium Moisture, Fluorescence microscopy and Scanning Electron Microscopy for a better understanding of coal properties.

## RESULTS AND DISCUSSION

The proximate analyses of the four samples collected are shown in Table 2. It can be seen that the coal sample is typical low rank coal younger formations from East Kalimantan of Indonesia with very low total sulphur & low ash content as well as low calorie.

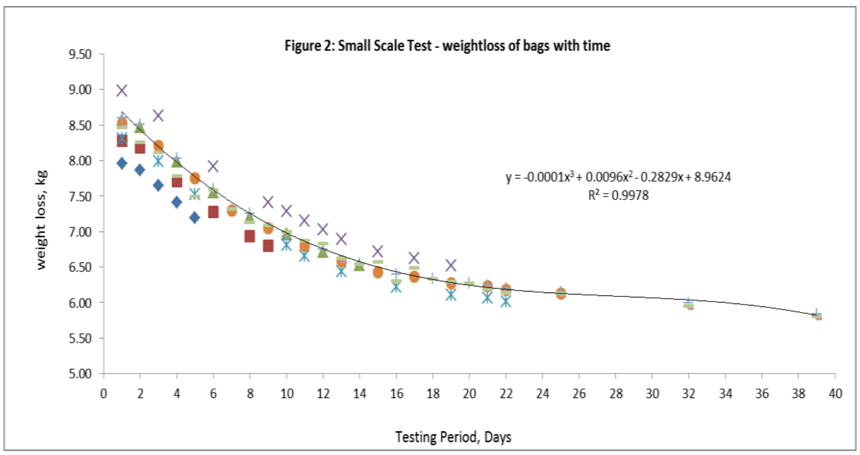
**Table 2: Proximate Analysis of crushed coal samples**

| Parameters | Units | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Average |
|---|---|---|---|---|---|---|
| Total Moisture | %ar | 49.83 | 45.88 | 46.46 | 47.51 | 47.42 |
| Moisture in Analysis Sample | %adb | 16.82 | 13.98 | 15.15 | 14.51 | 15.12 |
| Ash Content | %adb | 3.03 | 1.35 | 2.17 | 1.29 | 1.96 |
| Volatile Matter | %adb | 40.78 | 46.44 | 41.28 | 42.74 | 42.81 |
| Fixed Carbon | %adb | 39.37 | 38.23 | 41.40 | 41.46 | 40.12 |
| Total Sulfur | %adb | 0.13 | 0.11 | 0.14 | 0.14 | 0.13 |
| Calorific Value (adb) | Kcal/kg | 5373 | 5848 | 5501 | 5611 | 5583 |
| Density | gm/cc | 0.773 | | | | 0.77 |

The size distribution shows a mean size of 10mm and low proportions of ultra-fine material. This makes the crushed coal suitable for stockpile drainage as there should be ample clearance between particles. The coal is unlikely to have migration of sufficient quantities of fines to cause moisture build up and slumping.

## *MOISTURE& RAINFALL*

Moisture plays an important role on behavior of coals in stockpiles. The complexes processes of self- heating in the existence of water have been investigated by many workers. The small scale tests were conducted to investigate the potential to drain moisture from coal with time period in controlled ambient conditions. The tests show a consistent drainage profile for all tests. This has allowed a defined drainage relationship to be calculated. As these tests were conducted in the ideal conditions of no stockpile segregation, maximum gravity effect and shelter from rain re-wetting, they give indication of the maximum potential for moisture reduction via natural drainage.




The Results of eight samples are shown in the Figure 2. All the eight samples almost follow the identical trend of losing weight with time. At the end of each bags prefixed time completion the TM% was analyzed and the results are shown in Figure 3. As can be seen in Figure 3, all of the small scale tests displayed very similar drainage profiles. (R2 = 0.9877), Using the aggregated data, the moisture reduction has been shown to closely follow the polynomial equation:y = -2E-05x4 + 0.001x3 + 0.0082x2 - 1.3978x + 47.282

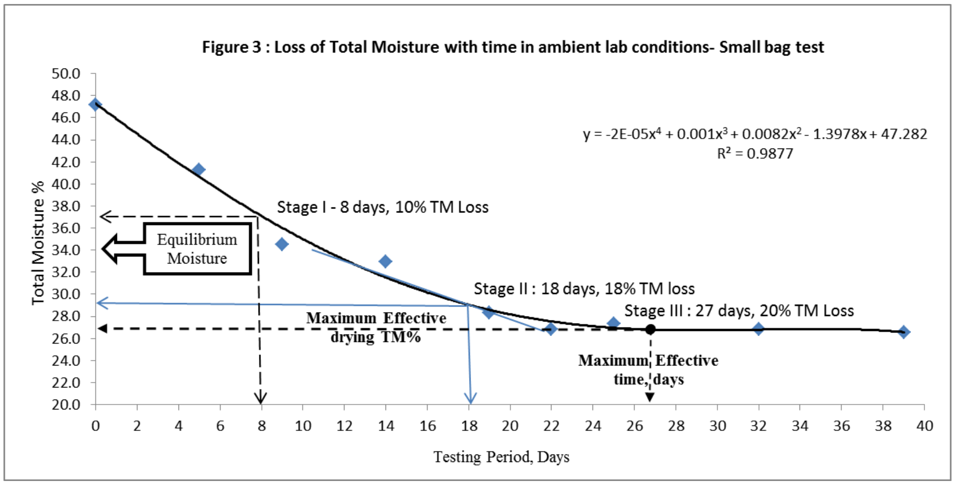


Figure 3 : Loss of Total Moisture with time in ambient lab conditions- Small bag test

The application of this relationship can determine the maximum drainage effect over a given time period. Figure 3 shows this drainage relationship calculated to Total Moisture, highlighting three different phases in the moisture loss over time.

The first phase (stage I) exhibits the maximum drainage of 10% over 8 days for an averaged loss rate of 1.25%/day. In the Stage I, sensible heat is transferred to the coal and the contained moisture. During this phase, the coal is heated from the inlet temperature to the process temperature. The rate of evaporation increases rapidly during this period and mostly free moisture is removed. The Equilibrium moisture of the tested coal is 34.2%. The initial quick loss of coal moisture is reaching the moisture holding capacity of coal. In other words, this amount of moisture represents the free moisture of coal in Stage I.

The mid phase (stage II) shows a slowing of the rate of drainage up to day 18 when a sharper decline in loss rate occurs. The average Loss Rate for the 18 days trial period was 1.0%/day. During the second phase, or constant-rate period, the surface of the coal is still wet. Evaporation continues at a constant rate. The heat transferred from the drying air is equal to the heat removed by evaporation of the water on the coal surface.

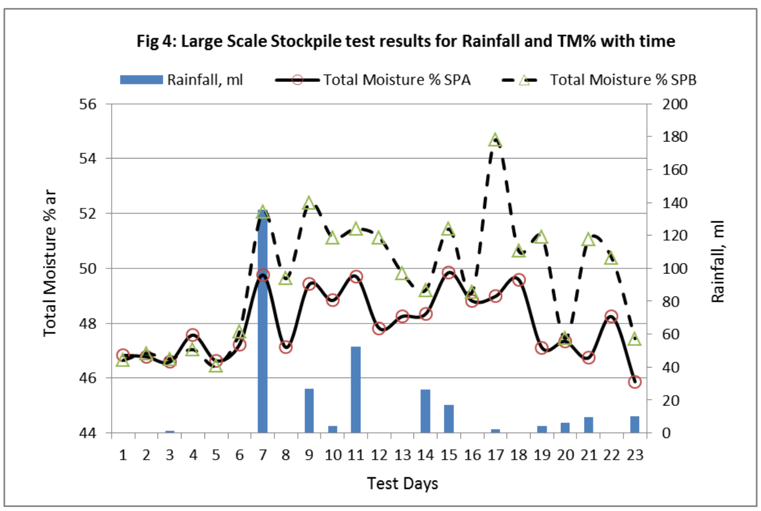
The extended trial to 38 days only reduced the moisture level by 0.74%/day. This would indicate that the potential beneficial drainage effects on stockpiled coal could be realized relatively quickly. Drying slows down due to the smaller wetted area exposed to the drying air. The nature of the coal now begins to play a more important role in determining the rate of release of moisture since the moisture has to migrate from the pores of the coal to the surface, which requires more energy.

Whilst the small scale results are undoubtedly also inclusive of evaporation losses, this is expected to have only a minor effect in comparison to the drainage loss. This is supported by the moisture analysis checks completed over a variety of time periods showing well aligned results against the overall profile. The profile also shows that after eighteen days, the loss rate drops substantially. This is indicative of a lessening gravitational effect on available free moisture. It is

likely that in a practical situation, moisture losses in the third phase will not be sustainable under ambient conditions.
The data supports a potential drainage beneficiation of coal moisture over a two to three week period. Stockpiling effects will likely decrease the drainage potential with more prolonged time. Lignite coals are easier to loose moisture than high rank coals [25, 26].

Figure 4 shows the moisture as determined on extracted samples from both large scale stockpile tests. Also includes the rainfall events during the trial period. Initial moisture loss appears to be minimal for the first few days. This delay in drainage was also observed in the small scale tests and may be due to free moisture accumulation to a concentration that precipitates gravitational drainage. The rain events have an obvious and significant effect on moisture levels throughout the tested area of the stockpiles.

The largest moisture loss as measured by extracted samples is observed to coincide with the periods of least rainfall. Rain days with less than ten millimeters of rainfall still allow a significant drainage while rain days with greater rainfall than 120 millimeters tend to increase the overall moisture levels. This rain effect ensured that the stockpiles actually increased in overall moisture content during the trial period. Both stockpile sets of data follow the rainfall closely, highlighting the significance of moisture addition from rain.

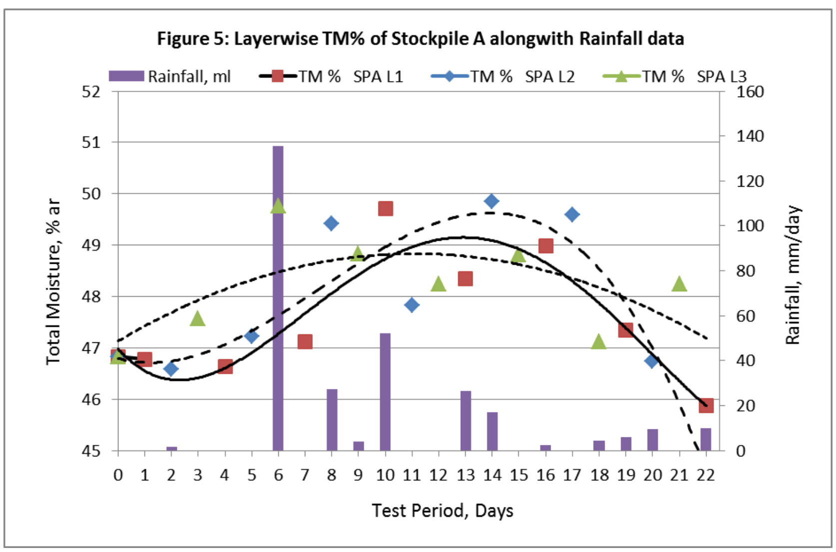


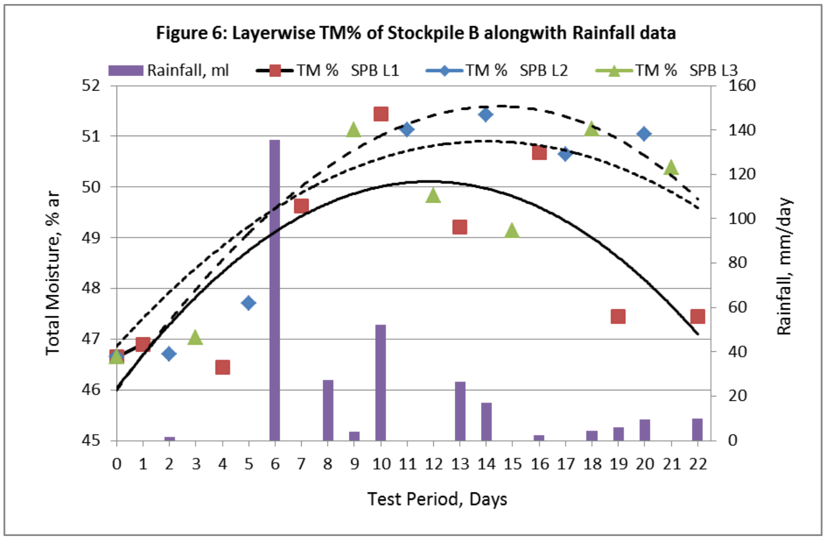

To evaluate what differences may be occurring to moisture content within the stockpile different levels, the extraction samples were positioned in three distinct layers. The information portrayed in Figure 5 and 6 represents the data from each stockpile according to the layer. Data from the two stockpiles shows some correlation though this tends to widen as the trial continued. In order to increase the reliability of data two stockpiles allows averaging of errors in measurement and heterogeneity. The top layer rapidly increases in moisture, as would be expected, on the addition of rain.

This layer also drains moisture quickly during dry periods. The middle layer shows similar increases due to rain as does the top layer, though initial drainage is not as quick as the top layer. The heating of low rank coalin stockpile was increased with decreasing particle size, increasing moisture content of the coal and decreasing humidity of the air[3]. Stockpile A displayed a much greater moisture loss rates during the later days of the trial than did stockpile B. The bottom layer must drain the free moisture horizontally rather than vertically as is possible for the higher layers and as such was expected to maintain a much higher moisture level. Test results do not, however, support this expectation. Both piles show a greater moisture reduction for the bottom layer. It must, therefore, be assumed that the piles were constructed to freely allow drainage of water from the base and presented little hydraulic back pressure within the stockpile that was overcome by the greater gravitational force propagating drainage.

This would suggest that the construction of the stockpile and the size distribution of the crushed coal do not present significant barriers to natural drainage in the present scenario [15].The top layer coal granules are broken to smaller size fractions due to decrepitating nature of high moisture low rank coal. Smaller grain sizes of the coals that the smaller the grain sizes the larger the surface area and the more contact with oxygen, and heat was continuously accumulated in the medium and could not be taken out, helps in lowering of total moisture in top layer [27]. Furthermore, drainage within the stockpiles not limited to the extremities and can be given a standardized draining profile.

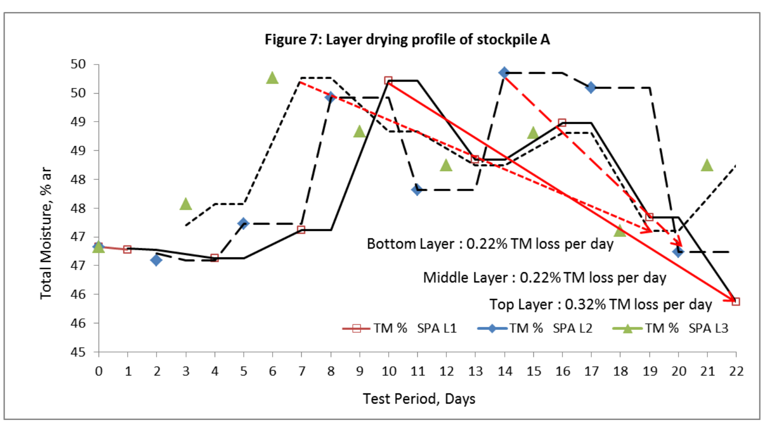
In order to further evaluate the movement of moisture vertically through a stockpile, the individual stockpile data has been aggregated. Drainage profiles can then be applied to establish the average drainage rates and the maximum drainage rates, for each level of the stockpile. Average drainage rates have been calculated from the peak moisture level in each stockpile layer






The variation in average draining rate for the aggregated stockpile layers shows a gradated rate (Figure 7 and 8) dependent on hydraulic gravitational pressure. This would indicate the likelihood that taller stockpiles would drain faster [17]. The ability of the stockpile base to shed water will impact significantly, which was mostly top soil clay.

The measured maximum drainage rates are also dependent on layer with the top layer draining fast in both the stockpiles. The rates are in line with those measured in the small scale tests with a large scale weighted layer maximum of 1.2% per day. The small scale trail average was 0.91% per day for the twenty two day period. This close correlation in both scale tests should provide good levels of confidence on predicting maximum moisture loss over time. However, due to the large scale trial being subject to increasing moisture content due to rainfall events, caution must be exercised in evaluating these results. Namely, the maximum rates have been determined from a greatly reduced period of time and the additional water in the stockpile may if fact give higher drainage rates.



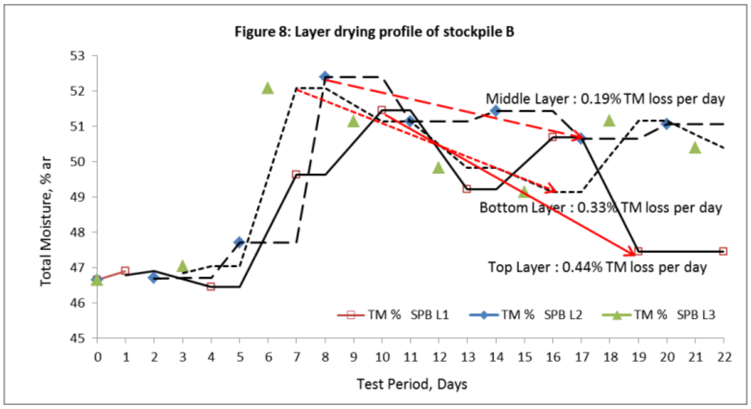
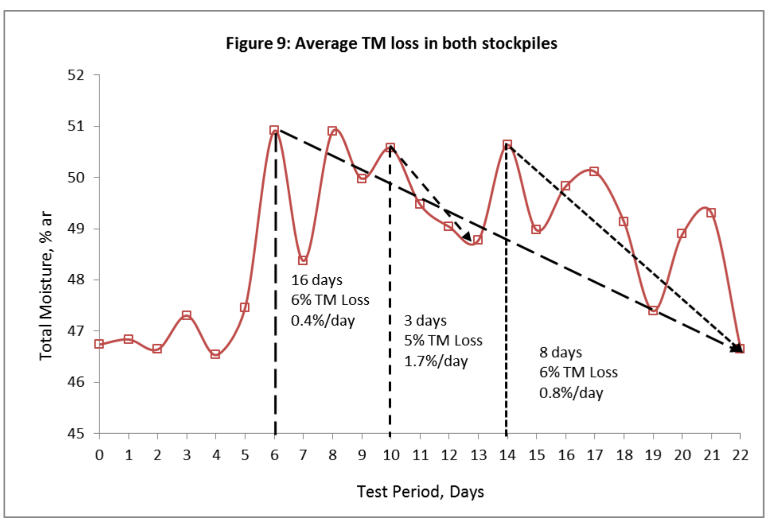


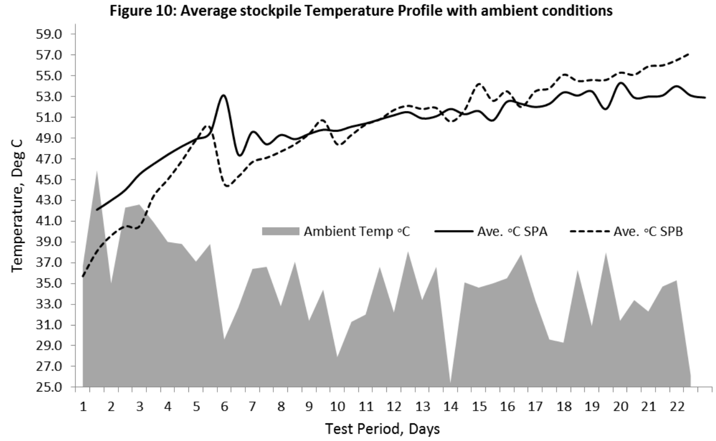

Figure 9 displays the aggregated stockpile moisture for all layers in both stockpiles. This should reduce any effects from homogeneity and stockpile construction anomalies. Three separate moisture loss rates have been calculated by basing the loss from a moisture peak roughly aligning with significant rain events.  While the interpreted moisture peaks may not directly be resultant from rainfall, the loss rates from each peak to the trial end allow valid calculation of moisture loss. The loss rates calculated from this scenario show reduced rates from the maximum rates calculated from Figure 7 and 8, they still indicate significant moisture loss. The period selected from day 10 to day 13 show a drainage rate 1.7%/day is in excess of the previously calculated loss rate of 1.3% per day maximum and 0.44 to 0.32% TM on average. Once again, these augers well for establishing a moisture loss profile with a high degree of confidence.



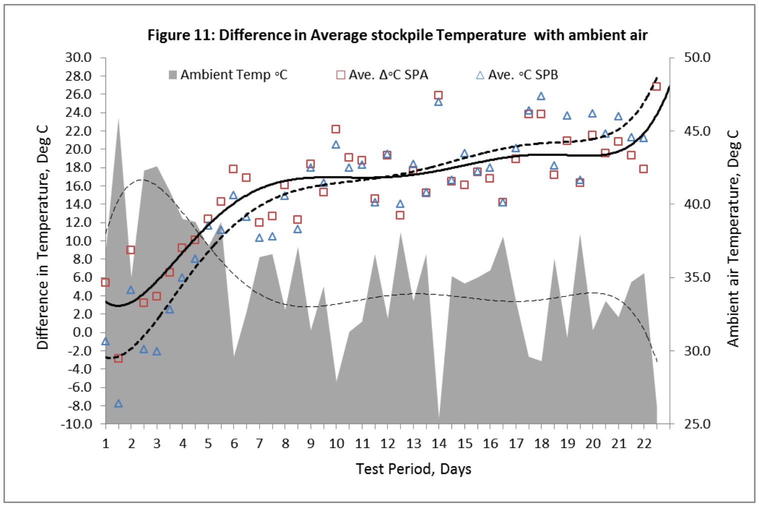
*AMBIENT AIR TEMPERATURE*

It has been found that inflow of air or oxygen into the stockpile is indispensable for durability of coal oxidation and heat accumulation inside the pile induces temperature rise over the critical value of about 200 °C. These two conditions for spontaneous ignition are met most in the edge of the stockpile [18]. The degrees of compaction and airflow rate effects of varying rates of air permeation on the coal oxidation process and change the stockpile temperature [8]. The temperature of both stockpiles shows a steady increase over time (Figure 10). Stockpile B had a lower start temperature but finished the trial period at a higher temperature than Stockpile A. This may be due to differences in stockpile construction or more likely, different exposures to predominant wind direction by virtue of shadowing from the other pile. Ambient temperature was very hot for the first five days and this has driven the stockpile temperatures up sharply. The rate of temperature increase, lowered slightly with cooler air temperatures. Numerical results showed that maximum temperature of the coal stockpile decreases as Re (or air ratio) increases. Air ratio enhancement improves the heat removal, but it also increases the coal oxidation process, so the intersection between air ratio and maximum temperature curves, when plotted versus Re, can be used to find out the safe (design) area [28].

Figure 10: Average stockpile Temperature Profile with ambient conditions



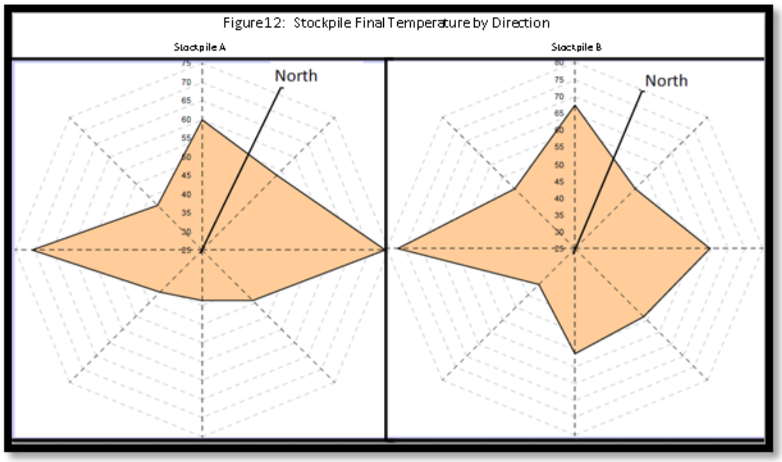

The cooling effect of the rain days can clearly be seen with the ambient temperatures dropping below 300C, however, the rate of temperature increase was at its steepest directly after the rain events. While the stockpile average temperatures remained below 600C, individual readings from segments of each stockpile reached in excess of 700C. The influences on stockpile temperature can be observed in Figure 11. While significant temperature drops are directly attributable to the cooling effects of the rain days, both cooling water ingress to pile and cooler ambient temperatures, the strong winds on hot days also have a marked effect. Another key parameter is represented by the volume-to surface ratio (V/A) of the pile. This is due to the fact that the heat generation as a result of chemical oxidation reactions is related to the volume, and the heat transfer to the surrounding is related to the surface of a reactive system [15]. It has been reported [5] that low rank coals undergo the highest heating rate when their moisture content is reduced to about one-third of the original as-received moisture content.




## *WIND*

Coal stockpiles exposed to strong winds are vulnerable to increased self-heating via oxidation processes driven by the increased oxygen available inside the pile. Worth noting is the tailing off of the temperature increases over the final five days of the trial. The weather conditions were cooler with several periods of light rain and moderate winds. This type of weather obviously allows greater net heat losses from the pile.

Although atmospheric temperature is low, low-temperature oxidation of coal in the stockpile continues for a long time and finally, it leads to spontaneous ignition followed by rapid combustion [29]. Hot days with strong winds with intermittent downpours provide little opportunity for the stockpile to loose heat and compound the situation when the rainwater percolates through the coal increasing heat generation by promoting oxidization. While there are some differences between the two piles, a strong correlation between wind direction and pile temperatures can be discerned. The predominant heating is observed in both piles at the west-south-west segment (Figure 12).




Taking into account the wind strength ambient temperature and humidity an evaporation factor has been estimated. The evaporation factor is useful in evaluating drying by evaporation. This also introduces another aspect in studying the heating of the piles as evaporation is endothermic and will assist in removal of heat. The factors are heavily weighted by the humidity and for most of the trial period the estimated evaporation factors were very low. As evaporative losses only occur from the outer surface of the stockpile, this is not a significant drying modus for large stockpiles over the short term with this climate profile. Benefits obtained via evaporation are easily lost with minor rain events.

The dominant wind strength directions align well with the final stockpile temperatures, reinforcing the effects of wind impact causing heat generation on stockpiles. The easterly winds over the last week of the trial period did not affect the same temperature increases as the strong northerly winds in the first week. It is expected that this is due to several reasons.

As the coal initially drains, exposure of oxidisable surface areas rapidly increases, the heat generated by exothermic reactions increases rapidly. The ability of the pile to divest this heat is severely hampered by high ambient temperatures and high humidity. [17]. This increasing temperature will in turn increase the moisture loss both via evaporation and by increased mobility of moisture within the pile. Slower, cooler winds will aid the pile in divesting heat and will not generate significant pressure differentials around a stockpile. Strong winds generate a pressure drop on the leeward side of a stockpile and this act to draw air deeper into the pile. High humidity will dampen any evaporative effects and decrease heat losses from the stockpile. The combination of high ambient temperature, strong wind and high humidity is the least helpful scenario for storage of coal in stockpiles.

## MACERALS CONSTITUENTS

Petrographic analysis of showed that the coal sample is having the highest inertinite group macerals. Inertinite group of macerals gets oxidized more easily [16]. Oxidation progresses with time for lower rank samples especially at relatively higher ambient temperatures causing rise in stockpile temperature, which results in loss of surface moisture of coal.

## CONCLUSION

The critical stockpile temperature has been stipulated as 60 ◦C and this temperature are likely to be reached in approximately 18 days. There is some evidence to suggest that the stockpile temperatures may reach higher than the suggested critical temperature before uncontrolled heating continues. Few occasions temperatures exceeded sixty degrees and then dropped. Of course, the impact on temperature of both wind and rain can dramatically change the heat generated from oxidation processes. This evaluation would suggest that, without consideration for the weather condition effecting the pile temperature and moisture, a natural drainage period of between 18 and 25 days would assist in the reduction of moisture associated with the coal. The reduced moisture content of the drained material could be expected to reach approximately 27% Total Moisture over this period.

Further, to evaluate the same coal with small stockpiles under ambient conditions but with and without shelter from rain and using different initial granulometry is in progress and will be communicated in near future.

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