Effect of Water and Chemical Spray on Quality Parameters TM, Ash, and CV of E4700 Product Coal at PT Adaro Indonesia Site Kelanis, South Barito Regency, Central Kalimantan

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Abstract. PT Adaro Indonesia is a coal producer that produces several types of coal using standard doses. However, to improve the quality of E4700 coal, the company needs to examine the effect of chemical use on coal quality. This study aims to determine the effect of the use of dust suppressant chemicals on the value of coal quality parameters, identify variables that have a significant effect on the calorific value of coal, and analyze the concentration level of chemicals that have a significant effect on changes in the value of quality parameters in E4700 coal. Based on the analysis, after spraying with chemicals, there is a change in the value of coal quality parameters. When using a chemical concentration of 25 ppm, there was a change in the value of Total Moisture by -0.62%, Ash by -0.04%, and calories (CV) by 47 cal/g. At a concentration of 35 ppm, the Total Moisture value changed by -1.58%, Ash by -0.16%, and calories (CV) by 117 cal/g. And at 50 ppm concentration, there was a change in Total Moisture value of -1.96%, Ash of -0.24%, and calories (CV) of 142 cal/g. These results indicate that the use of chemicals affects the quality of E4700 coal. This study also used multiple linear regression statistical tests to obtain the significance value of the Total Moisture variable.

Keywords: *quality control, chemical, quality analysis,*

1 Introduction

PT Adaro Indonesia is the largest coal mining operation within the Adaro Group, producing the group's main coal product, Envirocoal, a sub-bituminous coal with medium heating value and very low pollutant levels. Envirocoal's heating value range is from 4,000 kcal/kg to 5,000 kcal/kg and is one of the cleanest coals in the seaborne thermal coal market. PT Adaro Indonesia produces coal consisting of three pits, namely the Paringin, Tutupan, and Wara pits. The coal currently produced by PT Adaro Indonesia is E5000, E4900, E4700, E4200, and E4000, which products are obtained from coal blending.

Coal quality is determined by analyzing coal in the laboratory. (Nur, Z., Oktavia, et al, 2020) PT Adaro Indonesia made innovations in maintaining coal quality, especially in handling fine coal caused by the coal crushing process. Currently the company provides treatment to minimize fine coal with the water and chemical spray method, but there has been no study related to the effect of the use of these chemicals on several products offered by the company and there has also been no study related to the efficiency of use.

The concentration levels of chemicals used in Adaro's new product, the E4700 product, where the E4700 product is a blended coal from several raw materials originating from several seams in PT Adaro Indonesia, PT Adaro Indonesia still uses standard doses that have been applied previously to all products offered by PT Adaro Indonesia today, including the E4700 product.

For this reason, it is necessary to conduct research on the effect of chemicals on coal quality to determine the effect of the use of chemicals on the quality of E4700 coal and the concentration levels of chemicals that are efficient to be used by PT Adaro Indonesia.

Therefore, based on the background of the problem, the author wishes to conduct research with the title **"Effect of Water and Chemical Spray Use on TM,**

Ash, and CV Quality Parameters on E4700 Product Coal at PT Adaro Indonesia Site Kelanis, South Barito Regency, Central Kalimantan".

2 Research Location

2.1 Regional Convenience Location

1. To reach the location of PT Adaro Indonesia's mining activities can be reached through two routes, namely : By air by using an airplane. The route used is from Padang City, West Sumatra to Soekarno Hatta International Airport, Jakarta, with a travel time of ± 2 hours. Then proceed with the trip to the city of Banjarmasin, South Kalimantan with a travel time of ± 1 hour 45 minutes.
2. By land by car. The route is from Banjarmasin City to Tabalong Regency with a distance of ± 220 km. This route passes through Banjar Regency, Tapin Regency, and Hulu Sungai Selatan Regency with paved road conditions. Thisroad is part of the Trans Kalimantan Road that connects Banjarmasin City in South Kalimantan with Balikpapan City, East Kalimantan.

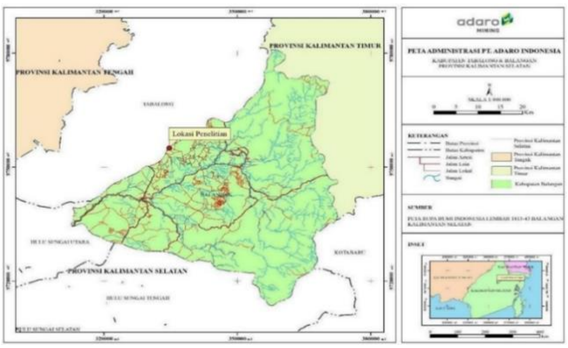

Figure 1. Administrative Map of Tabalong and Balangan Regencies

2.2 Geology

2.2.1. Geology

Down faults, up faults, horizontal faults, synclines, and anticlines are geological structures that exist in South Kalimantan. The direction of normal faults should generally be parallel to the fold axis and oriented northeast - southwest. Porphyry andesite rocks and Mesozoic rocks were uplifted in tectonic activities during the Paleocene. In the Albino group volcanic activity is Olistostrom formed at the end of early limestone. Breakthroughs that occur in granite and diorite break through malihan rocks in the early limestone period. The mixing of ultramafic rocks and malleable rocks took place since the Jurassic Period in the area of tectonic activity. In the early Eocene the Tanjung Formation was deposited in the Paralas arch. At the same time the Meratus complex was already present, but only in the form of a slightly higher area in the basin and deposited in the form of thinner sedimentary layers than the surrounding area. The Warukin Formation will form the low tide of the sea in the Miocene time. In the Berai Formation will be 17 forming sea inundation during the Oligocene. In the Pliocene will form Formation Dahor which causing faults to rise and shift and followed by down faults. Tertiary and PreTertiary rocks in the Miocene time will cause tectonic movements so that the rocks will be uplifted and form the Meratus Mountains and fold which can be seen in Figure 3 (Heryanto, 2010).

Figure 2. Plate Tectonic Conditions in the Late Cretaceous Eocene-Miocene in the Meratus Mountains

3 Theory Review

3.1 General Coal Analysis Parameters

3.1.1 Analysis Proximate

Proximate Analysis is a series that consists of determining inherent moisture, ash, volatile matter and fixed carbon. Proximate Analysis is the initial analysis in coal to meet consumer demand.

3.1.2 Inherent moisture

Inherent moisture can also be called air dried moisture, which is the moisture content contained in coal when examined or when it has been air dried. The size of IM is influenced by the coal rank, humidity level and temperature at the time the coal is analyzed, and also affects the sample preparation before IM is analyzed. Influenced by the coal rank, humidity level and temperature at the time the coal is analyzed, and also affects the sample preparation before IM is analyzed.

3.1.3 Volatile Matter

Fly content is also used as a parameter to separate and determine the ratio of coal in the blending process to produce good coke. Fly content can be calculated by the formula:

%Loss $= \frac{M2-M3}{M2-M1} \times 100\%$..(1)

Fly content = %loss - %moisture……..………..……(2)

Dimana :

M1 = Weight of initial sample + cup
M2 = Weight of sample after massaging
M3 = Weight of empty cup

3.1.4 Ash

The ash content can determine the appropriate utilization for the type of coal. Ash content can be calculated by the formula:

% ash content $= \frac{M2-M3}{M2-M1} \times 100\%$................................(3)

Where :

M1 = Weight of initial sample + cup
M2 = Weight of sample after massaging
M3 = Weight of empty cup

3.1.5 Fixed Carbon

Solid carbon content can be calculated with the following equation:

%Fixed Carbon = 100 − (% IM + % Ash + % VM)……(4)

Where :

% IM = Moisture (moist water)

% VM = Flying matter

% Ash

3.1.6 Calorific Value (CV)

In writing calorific value data, it is necessary to state the basis for the calculation, whether it is in a dry and mineral-free condition, 110°C dry, air dried or as received. Because during the actual combustion process in the boiler, this calorific value is never reached because some components of the coal, especially water, evaporate and disappear together with the heat of vaporization. The maximum calorific value that can be achieved during this process is the net calorific value. Calorific value is also known as specific energy and its units are kcal/kg or cal/g, MJ/kg, Btu/lb.

3.2 Statistics

3.2.1 Correlation

Correlation is a statistical method for determining whether a relationship exists between two variables (Bluman, 2012). Correlation is intended to quantify the strength or lack of relationship of the tendency of a linear relationship (Diez et al., 2015). Correlation attempts to measure the strength of the relationship between two variables with a number called the correlation coefficient (Walpole et al., 2012).

3.2.2 Pearson Product Moment Correlation Coefficient

The equation to determine the PPMC value is:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x2) - (\sum x)2][n(\sum y2) - (\sum y)2]}} \quad \ldots\ldots(5)$$

Description:

r = PPMC

n = Number of data

x = Value of the independent variable

y = Value of the dependent variable

3.2.3 Coefficient Of Determination

The equation for finding the coefficient of determination and undetermined is as follows:

$$R^2 = \frac{Described\ varians}{Total\ varians} = (r)^2 \ldots\ldots(6)$$

$$R^2 = 1 - R^2 \ldots\ldots(7)$$

Description:

R^2 = Coefficient of determination

R^2 = Coefficient of non-determination

3.2.4 Regression

Regression analysis is closely related to PPMC and scatter diagrams, the regression line has two functions: it predicts y values and helps calculate R2. The first function is most relevant and is where we should concentrate (De Vaus, 2002).

3.2.5 Simple Regression

When the analysis uses only one independent variable, it is called simple regression (De Vaus, 2002). Linear models can be used for relationships between two variables. However, this model has many limitations. Linear regression is a simple regression (Díez et al., 2015).

3.2.6 Multiple Regression

Multiple regression models are linear with multiple predictors (Díez et al., 2015), in the case of k independent variables $x1, x2, \ldots, xk$ which means $Y|x1, x2, \ldots, xk$ given multiple linear regression equation (Walpole et al., 2012).

4 Research Methods

4.1 Type of Research

The data to be obtained in this study are quantitative in nature which refers to experimental research. Quantitative research method is one type of research that is systematic, planned and clearly structured from the beginning of making research design to the conclusion stage (Wahidmurn, 2017).

4.2 Data Collection Technique

4.2.1 Literature Study

Literature study is part of research activities that aim to collect, study and read various literature sources in the form of books, previous research, data owned by the company and other sources that refer to things that support research activities.

4.2.2 Field Observation

4.2.2.1 Research Location

This research will be conducted in December 2022 at PT Adaro Indonesia Site Kelanis, Rangga Ilung Village, Jenamas District, South Barito Regency, Central Kalimantan.

4.2.2.2 Data Collection

In this study, the data that needs to be prepared is primary data and secondary data, including:

a. Primary data required for this research is in the form of coal sampling on the Belt Conveyor, Results of sample analysis at Idham Dahlan Shaleh laboratory, and field documentation.
b. Secondary data needed for this research are company profiles, rainfall data, and MSDS for PIC-105 chemicals.

4.2.3 Data Processing and Analysis Techniques

The initial stage to obtain data is by taking coal samples without being given chemicals, on the conveyor belt (Hopper 5). The sample used is coal from product E4700 Raw Material TSC 13 with a total sample weight of 200 kg.

After the researcher obtains primary data and secondary data, the researcher uses formulas through existing literature to analyze the data, data analysis, among others, is as follows:

a. Knowing the effect of using dust suppressant chemicals on the value of coal quality parameters (total moisture, ash content, and calorific value).
b. Knowing which quality parameter value variables have a significant effect on the calorific value of coal.
c. Analyze the chemcial concentration levels that significantly affect changes in the quality parameter values used in E4700 product coal.

5 Results and Discussion

5.1 Influence Usage Materials Chemicals on the Value of Coal Quality Parameters

The results of laboratory tests of coal with chemical doses (0 ppm, 25 ppm, 35 ppm, and 50 ppm) will be analyzed using multivariate statistical tests to determine which chemical doses significantly affect the value of coal quality parameters (TM, Ash, and CV). The following data from the Coal laboratory test results can be seen in Table 1 below:

Table 1. Laboratory Testing Results

HARI	Cuaca		0 ppm			25 ppm			35 ppm			50 ppm		
	Before Sampling	On Sampling	TM (%)	ASH (%)	CV (Cal/g)	TM (%)	ASH (%)	CV (Cal/g)	TM (%)	ASH (%)	CV (Cal/g)	TM (%)	ASH (%)	CV (Cal/g)
1	berawan	berawan	28.85	2.6	4706	28.93	2.64	4702	28.52	2.58	4708	28.89	2.52	4706
2	hujan (110 mm)	berawan	31.05	2.24	4561	29.77	2.16	4624	28.56	1.92	4693	28.05	1.72	4733
3	hujan (0.7 mm)	hujan (0.6 mm)	29.73	2.14	4585	28.82	2.13	4641	27.36	2.01	4785	26.79	1.97	4831
4	hujan (25.1 mm)	berawan	29.76	2.34	4655	28.98	2.23	4706	27.42	2.17	4795	27.01	2.03	4836
5	berawan	cerah	28.88	2.29	4658	28.21	2.21	4762	27.69	2.12	4873	27.04	2.06	4889
6	cerah	cerah	29.17	2.36	4695	28.82	2.39	4708	27.58	2.23	4779	26.82	2.16	4793
7	cerah	cerah	28.66	2.5	4719	28.2	2.43	4762	27.93	2.34	4762	27.79	2.35	4785
RATA-RATA			**29.44**	**2.35**	**4654**	**28.48**	**2.24**	**4744**	**26.97**	**2.20**	**4820**	**26.10**	**2.19**	**4863**

5.2 Influence Changes Value Quality Parameters on the Calorific Value of Coal

5.2.1 Effect of Total Moisture Value on Calorific Value of Coal

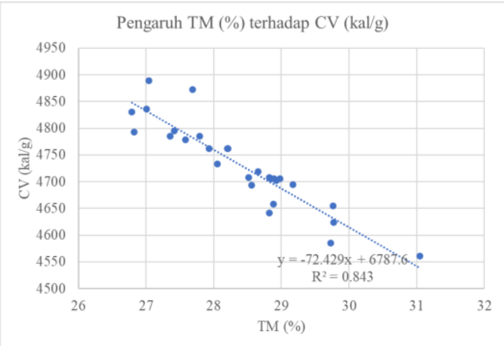

Figure 3. Effect of TM (%) on CV (cal/g)

Based on Figure 1 above, it can be seen that the correlation coefficient (r) obtained is 0.918 which shows that the Total Moisture (TM) and Calorific Value (CV) variables have a strong relationship that is close to perfect, then the coefficient of determination is 0.843 which shows that 84% of the variance of Calorific Value can be explained by Total Moisture and the remaining 16% is undetermined variance.

5.2.2 Effect of Ash Value on Calorific Value of Coal

The coefficient value obtained is 0.246 which indicates that the Ash and Calorific Value (CV) variables have a weak relationship, then the coefficient of determination is 0.0604 which indicates that only 6% of the variance of Calorific Value can be explained by Ash and the remaining 94% is undetermined variance.

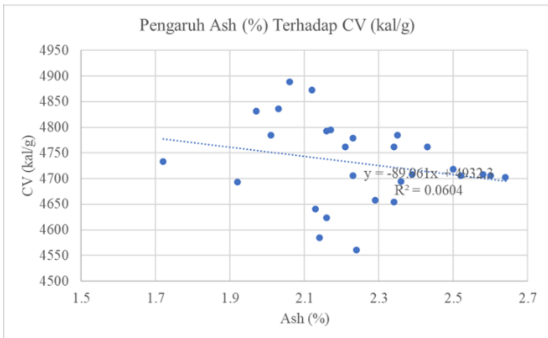

Figure 4. Effect of Ash (%) on CV (cal/g)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	6785.248	173.461		39.117	<.001
	Total Moisture	-75.003	6.529	-.951	-11.488	<.001
	Ash	33.626	30.291	.092	1.110	.278

a. Dependent Variable: Calorific Value

Table 2. Linear Regression

Based on Table 2 above, it can be seen that the constant value (α value) is 6785.248, and for total moisture (β value) is - 75.003, and ash (β value) is 33.626, so that a multiple linear regression equation can be obtained as follows:

$$Y = 6785{,}248 + (-75{,}003)\ X_1 + 33{,}626\ X_2 + e \text{..........(8)}$$

Which means:

1. The significance value (P value) on the Total Moisture variable is <0.001 or <0.05, which means that the Total Moisture value has a significant influence on changes in the calorific value of coal.
2. The significance value (P value) in the Ash variable is 0.278 or > 0.05, which means that the Ash value

has an influence but the effect is not significant on changes in the calorific value of coal.

3. The coefficient of X_1 (Total Moisture) is -75.003 which means that every time there is an increase in the variable X_1 (Total Moisture) by 1%, the calorific value will decrease by 75.003 (75 cal/g), or vice versa, every time there is a decrease in the variable X_1 (Total Moisture) by 1%, the calorific value will increase by 75.003 (75cal/g).
4. The X_2 coefficient is 33.626, which means that every time there is an increase in the X_2 (Ash) variable by 1%, the calorific value will increase by 33.626 (34%), or vice versa, every time there is a decrease in the X_2 (Ash) variable by 1%, the calorific value will increase by 33.626 (34%).

5.2.3 Analysis of the efficiency of using chemical doses in coal product E4700.

Multivariate statistical test modeling aims to obtain equations and determine the significance value of each chemical dose using 3 independent variables namely Total Moisture, Ash, and Calorific Value with the help of SPSS software, the results of data processing using SPSS can be seen in Tables 3 and 4, and the description below:

Table 3. Box's Test

Box's Test of Equality of Covariance Matrices[a]

Box's M	F	df1	df2	Sig.
17.743	.755	18	2035.436	.755

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + Treatment

Box's Test is used to test the homogeneity of covariance between groups. The significance value obtained is 0.755> 0.05, meaning that there is no difference in covariance / variance matrix between groups, so the sample is homogeneous.

Table 4. Multivariate Test

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[d]
Intercept	Pillai's Trace	1.000	374889.505[b]	3.000	22.000	<.001	1124668.515	1.000
	Wilks' Lambda	.000	374889.505[b]	3.000	22.000	<.001	1124668.515	1.000
	Hotelling's Trace	51121.296	374889.505[b]	3.000	22.000	<.001	1124668.515	1.000
	Roy's Largest Root	51121.296	374889.505[b]	3.000	22.000	<.001	1124668.515	1.000
Treatment	Pillai's Trace	.640	2.168	9.000	72.000	.034	19.509	.849
	Wilks' Lambda	.365	3.060	9.000	53.693	.005	21.433	.872
	Hotelling's Trace	1.726	3.964	9.000	62.000	<.001	35.680	.990
	Roy's Largest Root	1.719	13.752[c]	3.000	24.000	<.001	41.257	1.000

a. Design: Intercept + Treatment

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

d. Computed using alpha = .05

The significance value obtained from the four test methods used obtained a significance value (p-value) <0.05, so simultaneously there is a significant effect of treatment (chemical dosage) on the value of coal quality parameters.

Table 5. Levene's Test

Levene's Test of Equality of Error Variances[a]

		Levene Statistic	df1	df2	Sig.
Total Moisture	Based on Mean	1.219	3	24	.324
	Based on Median	.448	3	24	.721
	Based on Median and with adjusted df	.448	3	18.648	.722
	Based on trimmed mean	1.094	3	24	.371
Ash	Based on Mean	.534	3	24	.663
	Based on Median	.348	3	24	.791
	Based on Median and with adjusted df	.348	3	20.976	.791
	Based on trimmed mean	.529	3	24	.667
Calorific Value	Based on Mean	.090	3	24	.965
	Based on Median	.095	3	24	.962
	Based on Median and with adjusted df	.095	3	23.640	.962
	Based on trimmed mean	.091	3	24	.964

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Treatment

Levene's Test is used to identify the significance value that will affect the type of post hoc test to be used, if the significance value is > 0.05 then the post hoc test used is the Bonferroni test, while if the significance value is < 0.05 then using Games-Howell. Since all variables have the same significance value of > 0.05, the post hoc test to be used is the Bonferroni test.

Tabel 6. Multiple Comparisons

Multiple Comparisons

Bonferroni

Dependent Variable	(I) Dosis Chemical	(J) Dosis Chemical	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Total Moisture	0 ppm	25 ppm	.6243	.36244	.587	-.4178	1.6663
		35 ppm	1.5771*	.36244	.001	.5351	2.6192
		50 ppm	1.9586*	.36244	<.001	.9165	3.0006
	25 ppm	0 ppm	-.6243	.36244	.587	-1.6663	.4178
		35 ppm	.9529	.36244	.088	-.0892	1.9949
		50 ppm	1.3343*	.36244	.007	.2922	2.3763
	35 ppm	0 ppm	-1.5771*	.36244	.001	-2.6192	-.5351
		25 ppm	-.9529	.36244	.088	-1.9949	.0892
		50 ppm	.3814	.36244	1.000	-.6606	1.4235
	50 ppm	0 ppm	-1.9586*	.36244	<.001	-3.0006	-.9165
		25 ppm	-1.3343*	.36244	.007	-2.3763	-.2922
		35 ppm	-.3814	.36244	1.000	-1.4235	.6606
Ash	0 ppm	25 ppm	.0400	.11132	1.000	-.2801	.3601
		35 ppm	.1571	.11132	1.000	-.1629	.4772
		50 ppm	.2371	.11132	.262	-.0829	.5572
	25 ppm	0 ppm	-.0400	.11132	1.000	-.3601	.2801
		35 ppm	.1171	.11132	1.000	-.2029	.4372
		50 ppm	.1971	.11132	.536	-.1229	.5172
	35 ppm	0 ppm	-.1571	.11132	1.000	-.4772	.1629
		25 ppm	-.1171	.11132	1.000	-.4372	.2029
		50 ppm	.0800	.11132	1.000	-.2401	.4001
	50 ppm	0 ppm	-.2371	.11132	.262	-.5572	.0829
		25 ppm	-.1971	.11132	.536	-.5172	.1229
		35 ppm	-.0800	.11132	1.000	-.4001	.2401
Calorific Value	0 ppm	25 ppm	-46.57	31.647	.925	-137.56	44.42
		35 ppm	-116.57*	31.647	.007	-207.56	-25.58
		50 ppm	-142.00*	31.647	<.001	-232.99	-51.01
	25 ppm	0 ppm	46.57	31.647	.925	-44.42	137.56
		35 ppm	-70.00	31.647	.220	-160.99	20.99
		50 ppm	-95.43*	31.647	.036	-186.42	-4.44
	35 ppm	0 ppm	116.57*	31.647	.007	25.58	207.56
		25 ppm	70.00	31.647	.220	-20.99	160.99
		50 ppm	-25.43	31.647	1.000	-116.42	65.56
	50 ppm	0 ppm	142.00*	31.647	<.001	51.01	232.99
		25 ppm	95.43*	31.647	.036	4.44	186.42
		35 ppm	25.43	31.647	1.000	-65.56	116.42

Based on observed means.
The error term is Mean Square(Error) = 3505.357.
*. The mean difference is significant at the .05 level.

Multiple Comparisons are used to identify the significance value between Chemical Dosage variables so that it can be seen which chemical doses significantly affect changes in the value of coal quality parameters by comparing coal sprayed with chemicals (25 ppm, 35 ppm, and 50 ppm) with coal that is not sprayed with chemicals (0 ppm). Based on table 10, it can be seen that in the Total Moisture variable, the significance value is at chemical doses of 35 ppm and 50 ppm, then in the Ash variable there is no significant effect on any chemical dose variable, and in the Calorific Value variable, the significance value is at chemical doses of 35 ppm and 50 ppm. comparing coal sprayed with chemicals (25 ppm, 35 ppm, and 50 ppm) with coal that is not sprayed with chemicals (0 ppm). Based on table 10, it can be seen that in the Total Moisture variable, the significance value is at chemical doses of 35 ppm and 50 ppm, then in the Ash variable there is no significant effect on any chemical dose variable, and in the Calorific Value variable, the significance value is at chemical doses of 35 ppm and 50 ppm.

6 Conclusions and Suggestions

6.1. Conclusion

Based on the analysis that has been carried out, the following conclusions are obtained:

1. Based on the results of laboratory testing, as well as graphical analysis, the use of chemicals has an influence on coal quality parameters. Especially in total moisture, ashcontent and calorific value. Changes in the value of quality parameters in 50 kg of coal after being sprayed with chemicals which are then carried out General Analysis in the laboratory for 7 days, in the 25 ppm sample is TM = -0.62%, Ash = - 0.04%, calories (CV) = 47 kal/g, in the 35 ppm sample is TM = -1.58%, Ash = - 0.16%, calories (CV) = 117 kal/g, and in the 50 ppm sample is TM = - 1.96%, Ash = -0.24%, calories (CV) = 142 kal/g.
2. Based on the results of graphical testing with the correlation coefficient test and the coefficient of determination to determine the strong value of the relationship between the value of coal quality parameters and the calorific value of coal, for the Total Moisture variable, a correlation coefficient value of 0.918 is obtained which shows a strong relationship that is close to perfect and the coefficient of determination is 0.843, and in the Ash variable, a correlation coefficient value of 0.246 is obtained which shows a weak relationship and a coefficient of determination of 0.0604. In the multiple linear regression statistical test, the significance value of the Total Moisture variable was <0.001 and the Ash variable was 0.278.
3. Based on the results of the Multivariate statistical test, it is obtained that the sample used is homogeneous, simultaneously the dose of chemicals (25 ppm, 35 ppm, and 50 ppm) can affect changes in the value of coal quality parameters, but the doses of chemicals that have a significant effect are 35 ppm and 50 ppm (standard chemical doses used in the company, which means that based on this research the company can try using chemicals with a dose of 35 ppm.

6.2. Advice

1. When sampling the coal to be analyzed, it should be done with the correct sampling technique, because errors in sampling can result in the analysis sample not being able to represent / not representative of the actual coal population.
2. When doing sample preparation, it should also be done correctly and in accordance with the standard measurement method used, because if there are errors in the preparation stage, it will result in errors in the results of sample analysis in the laboratory later.
3. It is better to conduct further research by adding several variables such as how long the effect of these chemicals can last after being applied to coal and the effectiveness of using chemicals on dust populations.

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