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The Characterization of Coal-Fired Particulates in Electric Steam Power Plant - X, North Sumatra

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Abstract: ***The Coal derived from the mine often does not meet the requirements that are in accordance with the wishes of consumers (users) or by industries that need it. Coal related problem is the tendency that coal is very difficult to fulfill the requirement of clean energy utilization in Electric Steam Power Plant that matches environmentally friendly criteria. Various kinds of problems put forward from the use of coal in the processing of the steam power plant is a relatively large fly ash when compared with large companies abroad. To achieve optimal production yield, Electric Steam Power Plant has obstacle in the form of gas tendency in the form of fly ash and lack of handling or alternative tool that pay attention to environmental sustainability. Therefore, washing is part of a series of coal procurement process in accordance with consumer wishes. The purpose of this study is to analyze the coal characteristics of the mines used by the power plant based on the provisions of the quality / standard in order not to pollute the environment, to examine the results of the proximate analysis of the washing coal which is bought to know the effect of coal combustion and to know the particulate concentration of fly ash coal in Electric Steam Power Plant – X and the impact it has on the environment. The methodology used is exploratory survey method and using qualitative descriptive analysis using approach method of Standard Operational Procedure SEM (Scanning Electron Miscroscope), XRD (X-Ray Diffraction), and XRF (X-Ray Fluorescence). Based on the result analysi in this study using proximate analysis, it is produced that the coal used as fuel in the X-power plant has been in accordance with the provisions applicable to the utilization of coal in the Electric Steam Power Plant - X. In the analysis results using XRD seen that there are content of Alumina, Cacium Titanium Iron Oxide, Hedenbergite, Quartz and Magnetite. The XRF analysis result obtained fly ash composition from Silo and from disposal area. The conclusion of this study is the preparation activity (leaching of coal) can significantly decrease ash content, where ash content of coal bait based on floating-settling test at -70 + 50 mm is 7.91% and in size -50 + 32 mm is 5.73% and the size of -32 + 2.3 is 6.73% and the calculation of particulate fly ash coal concentration around Electric Steam Power Plant - X exiting with the exhaust gas does not exceed the threshold required by the Ministry of Environment of the Republic of Indonesia Year 2014. Hopefully this research will be useful for stakeholders both in electricity world, industry, academia and many coal mining practitioners so as to provide information on the characteristics and characteristics of the coal used so that it can be designed the combustion tool in accordance with the characteristics of the coal and facilitate the preparation coal on its utilization.***

Keywords: Coal, Fly Ash, SEM (Scanning Electron Miscroscope), XRD (X-Ray Diffraction), and XRF (X-Ray Fluorescence)

1. Introduction

The coal derived from the mine often does not meet the requirements that are in accordance with the wishes of consumers (users) or by industries that need it. Coal related problem is the tendency that coal is very difficult to fulfill the requirement of clean energy utilization in Electric Steam Power Plant that matches environmentally friendly criteria. Various kinds of problems put forward from the use of coal in the processing of the steam power plant is a relatively large fly ash when compared with large companies abroad. To achieve optimal production yield, Electric Steam Power Plant has obstacle in the form of gas tendency in the form of fly ash and lack of handling or alternative tool that pay attention to environmental sustainability. Therefore, washing is part of a series of coal procurement process in accordance with consumer wishes.

The purpose of this study is to analyze the coal characteristics of the mines used by the power plant based on the provisions of the quality / standard in order not to pollute the environment, to examine the results of the proximate analysis of the washing coal which is bought to know the effect of coal combustion and to know the particulate concentration of fly ash coal in Electric Steam Power Plant - X and the impact it has on the environment.

2. Literature Review

The process of burning coal will take place well if there is sufficient air available. Coal combustion process is a complex science due to the variance of the physical and chemical conditions of coal, but usually the combustion reaction of coal is described by the oxidation reaction of carbon to produce mono-oxide or carbon dioxide carbon. The composition of gases in the atmosphere can change due to air pollution due to natural activities and from various human activities. Air pollution sources can come from forest fires, dust, industry and transportation equipment such as motorized vehicles and vehicles in the form of heavy equipment that uses fuel. Air pollutants (pollutants) can generally be classified into two basic groups, namely particles and gas.

Air pollution by various types of pollutants can reduce air quality. Declining air quality for the respiration of all organisms (especially humans) will reduce the level of public health. Smoke from forest fires can cause irritation of the respiratory tract, even the occurrence of acute respiratory infections (ARI). Every occurrence of forest fires is always followed by an increase in cases of respiratory tract infections. The amount of pollutants released into the air in time units is called emissions. Emissions can be caused by biogenic emissions (natural processes) for example, CH4 resulting from the degradation of organic matter by microbes

and anthropogenic emissions (human activities) such as motor vehicle fumes, factory smoke and combustion waste.

The research approach used in this research is exploratory research analysis. Nazir (2005) explains that exploratory survey methods are often used to reveal facts and identify problems and get justification for ongoing implementation. In line with this statement, this research has the purpose to explain the fact of coal processing at Electric Steam Power Plant. Seeing the fact that coal processing at Electric Steam Power Plant resulted environmental damage in the air, causing a tendency to innovate by making an alternative form of coal washing process using Chance Cone. For this reason, it is necessary to investigate further the suitability of coal used by Electric Steam Power Plant and how there is the potential for an alternative form of coal washing process using Chance Cone.

3. Methodology

The data in this study are qualitative and quantitative. Qualitative data is more in the form of words, then the interview becomes very important device. The interview is an effort to collect information by using a number of questions orally to answer verbally (Nawawi, 1993). The main questions will be designed in the form of open questions, easy understood, neutral, and not colored by certain values or character direct. Furthermore, more specific data collection will conducted through observation by involving researchers as observers (participant observation) and in-depth interview (independent interview). Activity data collection will be carried out continuously until it reaches a point saturation. In this interactive model data analysis, the components data analysis namely; data reduction, data presentation, and conclusion drawing; interactively interconnected during and after data collection. The data obtained from observation, interview, and documentation supporting secondary data from Electric Steam Power Plant in Langkat area, North Sumatra.

4. Result

Proximate Analysis

This study carried out a proximate analysis that is commonly carried out on the use of coal either by mining companies or buyers as users. This proximate analysis is quite simple but requires special and standard equipment. Proximate analysis consists of four analysis values which, if added together, will be 100%, namely:

1) Moisture content
2) Ash (ash)
3) Flying substances (volatile matter)
4) Carbon fixed (fixed carbon)

The fourth value calculated in the proximate analysis is tethered carbon, which is obtained from 100% minus the amount of moisture content, ash content and flying matter (Sudarsono, 2003). The results of the proxy analysis obtained from the sample taken in the stockpile of Electric Steam Power Plant - X are shown in the table below as follows:

Table 1: Coal proximate analysis data

Tanggal	Kadar Lengas (%)	Kadar Abu (%)	Zat Terbang (%)	Karbon Tertambat (%)	Jumlah (%)
13 Januari 2017	14,41	3,26	43,11	39,22	100
10 Mei 2017	13,21	2,60	44,43	39,76	100

Source: Sucofindo, 2017

The table above shows that the coal used as fuel in the Electric Steam Power Plant - X is in accordance with the provisions applicable to the use of coal in Electric Steam Power Plant - X. Basically there are about 16 or more parameters determining the quality of coal but in its utilization, not all parameters must be met, but only according to their use. Coal quality requirements for the Electric Steam Power Plant industry:

1) Water content of 23.6%
2) Ash Content 7.8%
3) Flying substances 30.3%
4) Calorivic Value 5,242 Kcal / Kg
5) Total Sulfur 0.4%
6) Alkali in Abu Max. 2 ° 10
7) Hardgrove Index 50-62

Table 2: Proximate analysis based on laboratory result

Parameters	Units	Results				Methods
		As Received Basis	Air Dried Basis	Dry Basis	Dry Ash Basis	
Proximate Analysis :						
- Total Moisture	%	33.47	-	-	-	ASTM D 3302M -17
- Inherent Moisture	%	-	13.21	-	-	ASTM D 3173-17
- Ash Content	%	1.99	2.60	3.00	-	ASTM D 3174-12
- Volatile Matter	%	34.06	44.43	51.19	52.77	ASTM D 3175-17
- Fixed Carbon	%	30.48	39.76	45.81	47.23	ASTM D 3172-13
Total Sulfur	%	0.19	0.25	0.29	0.30	ASTM D 4239-14 (A)
Gross Calorific Value	Kcal/Kg	4325	5643	6502	6703	ASTM D 5865-13
Ultimate Analysis :						
- Total Moisture	%	33.47	-	-	-	ASTM D 3302M-17
- Inherent Moisture	%	-	13.21	-	-	ASTM D 3173-17
- Ash Content	%	1.99	2.60	3.00	-	ASTM D 3174-12
- Sulfur	%	0.19	0.25	0.29	0.30	ASTM D 4239-14 (A)
- Hydrogen	%	4.38	5.72	6.59	6.79	ASTM D 5373-14
- Carbon	%	46.04	60.07	69.21	71.35	ASTM D 5373-14
- Nitrogen	%	0.71	0.92	1.06	1.09	ASTM D 5373-14
- Oxygen	%	13.21	17.23	19.85	20.47	ASTM D 3176-15
HGI	Index	-	62	-	-	ASTM D 409M-16
Size Distribution						
Passing mesh 70 mm (-70)	%	97.81				ASTM D 3174-2004
Passing mesh 50 mm (-)	%	92.48				ASTM D 3174-2004
Passing mesh 32 mm (-)	%	75.59				ASTM D 3174-2004
Passing mesh 2,38 mm (-)	%	16.24				ASTM D 3174-2004
Ash Analysis						
- SiO_2	%	40.32				ASTM D 3682-13
- Al_2O_3	%	15.75				ASTM D 3682-13
- Fe_2O_3	%	19.00				ASTM D 3682-13
- CaO	%	11.68				ASTM D 3682-13
- MgO	%	5.51				ASTM D 3682-13
- K_2O	%	0.67				ASTM D 3682-13
- Na_2O	%	0.71				ASTM D 3682-13
- MnO_2	%	0.10				ASTM D 3682-13
- TiO_2	%	0.43				ASTM D 3682-13
- $P2O_5$	%	0.49				ASTM D 2795-95
- SO_3	%	4.43				ASTM D 5016-08e1
Slagging Factor	Index	0.19				Low
Fouling Factor	Index	0.47				Med
Sodium in Ash		0.53				
Ash Fusion Temperature		**Reducing**		**Oxidizing**		
- Initial Deformation	°C	1150		1220		ASTM D 1857-10
- Spherical	°C	1160		1230		ASTM D 1857-10
- Hemispherical	°C	1170		1250		ASTM D 1857-10
- Flow	°C	1180		1270		ASTM D 1857-10

Particulate Concentration

The concentration of particulates in the study at the Electric Steam Power Plant - X is measured in terms of PM8 coarse particles, PM2.5 fine particles, PM1 ultrafine particles. The concentration of particulates found around the study area in ambient air can be related to air quality and also have an impact on human health and the surrounding environment. Judging from its particulate form it consists of various forms of aerosols (dispersed solids or liquids in gas), dust, fog, fume or smoke resulting from condensation, baze (a combination of droplets of water, gas and dust), mists (liquid particles), particles, smoke or smoke from combustion, smog (a form of smoke and fog) and soot (Arinto, 2016). Particulate toxicity is affected by two factors, namely chemical composition and particulate size. From the results of the research on Electric Steam Power Plant - X by taking samples in the form of fly ash at the disposal area of the combustion product in Electric Steam Power Plant- X, a particulate sample is obtained in the form of dust with a chemical composition based on laboratory analysis of element content or chemical composition (XRF) of Electric Steam Power Plant - X fly ash . The following is the analysis table using the XRD method as follows:

Table 3: Data analysis based on XRD method

Kandungan	Persentase (%)	Rumus Senyawa
Alumina	12	Al_2O_3
Calcium Titanium Iron Oxide	5	$Ca_3TiFe_2O_3$
Hedenbergite	24	$CaFe(Si_2O_6))$
Quartz	50	SiO_2
Magnetite	8	Fe_3O_4

Based on the results of XRD analysis, it can be seen from the table that the Electric Steam Power Plant - X contained Alumina (Al as much as 12% with an intensity of 960 cps, Calcium Titanium Iron Oxide) of 5% with an intensity of 360 cps, Hedenbergite)) as much as 24% with an intensity of 320 cps, Quartz (50% with an intensity of 180 cps, and Magnetite with an intensity of 320 cps and the size of Crystal D = 61.95 nm. The largest content is Quartz content and the smallest is Calcium Titanium Iron Oxide.

Particulate Size and Shape at Electric Steam Power Plant – X

The figure below shows the description and shape of the particulates tested in the Scanning Electron Microscopy (SEM) laboratory with the ability to magnify to sub-microns, where the samples tested were taken directly from the bin silo reservoir in the Electric Steam Power Plant - X,

in Figure 1 below most rounded particulate shapes appear to be sized on the image below is measured in a random way, with a diameter of 4.063 µm and the smallest particulate size of 391.0 nm. In the figure, it can be seen that the shapes of particulates are more varied where the particulates are measured in the form of cubes with a length of 5.169 µm. In the figure there are varied particulate shapes but many appear to be hollow round sizes where particulates measured here from particulates are 19.99 µm. The largest particulate size is 33.51 µm and is round in shape and most particulates appear smaller. Whereas from the other picture, the largest particulate size was 4.201 µm and the smallest particulate 233.1 nm.

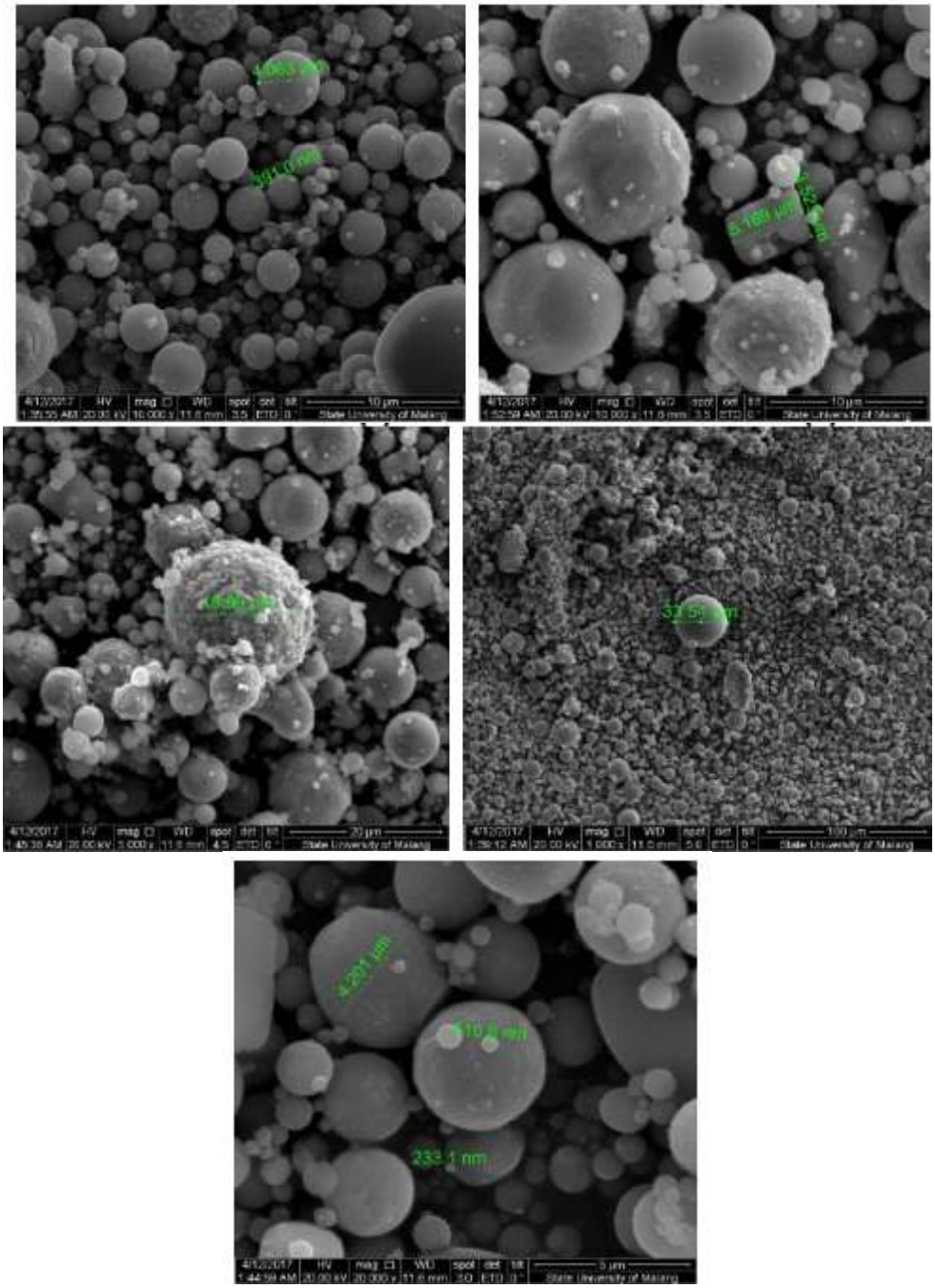

Figure 1: Particulate size and shape in ELECTRIC STEAM POWER PLANT - X

Based on medical record data obtained at the Hospital located near the power plant area at the study site, it was found that there were many illnesses suffered by the community around the power plant area. In this study, whether the power plant operation has an impact on the surrounding community on some of the diseases caused. In this test, it was carried out using a statistical approach to test before and after the existence of a power plant which had an impact on the incidence of illness suffered by the community around the power plant. Some diseases obtained based on medical record data in hospitals around power plant include tuberculosis with clinical smear, TB with positive smear, whooping cough, clinical malaria, pneumonia, and dysentery. The disease was processed using the Paired Sample Statistics approach during 2011 to 2016.

5. Conclusion and Suggestion

The conclusions obtained from this study are 1) Based on the analysis of the characteristics of coal from the mines

used by Electric Steam Power Plant - X, treatment is needed in the form of washing and mixing so that it does not lead to one of the mines, so coal is washed from the mine (ROM) will produce coal low ash content, 2) Based on the results of proximate analysis carried out in Electric Steam Power Plant - X shows that the effect of coal combustion requires moisture content, ash content, flying substances and tethered carbon that require special and standard equipment to facilitate preparation activities, 3) Based on the calculation Coal fly ash particulate concentrations around Electric Steam Power Plant - X that come out with flue gas through the chimney for 60 minutes with the results of these concentrations do not exceed the threshold required by the Ministry of Environment of the Republic of Indonesia in 2014.

4.1 Suggestion

Coal combustion carried out at Electric Steam Power Plant - X in addition to washing and mixing (belending) should be carried out by upgrading coal (UBC) and the watering so that moisture content can be reduced or lost so as to increase combustion efficiency and reduce the level of particulates released with the exhaust gas.

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