Decreasing the ash coal and sulfur contents of sawahlunto subbituminous coal by using “minyak jelantah”

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Abstract. Ash and sulfur caused low calorific value of coal and difficult to ignite the coal. The ash of the combustion product will pollute the environment. Through the conducted experiments the results of sulfur analysis on the coal tested were obtained. Five (5) experiments were conducted with different sample weights in the laboratory. In sample 1, the weight of the original coal sample of 0.2500 grams generated a level of sulfur content of 1.23%. In sample 2, the sample weight of 0.2500 grams of coal + 5ml of oil generated a level of sulfur content of 0.976%. In Sample 3, Coal + 10 ml of oil, where the sample weight was 0.2500 grams generated a level of sulfur content of 0.802%. In Sample 4, Coal + 15ml of oil, where sample weight was 0.2500 grams generated sulfur content of 0.609%. In Sample 5, Coal + 20 ml of “minyak jelantah” (used cooking oil), where the sample weight was 0.2500 grams generated a sulfur content of 0.428% and also a decrease in the value of the ash content. The coal was originally 62.80 and after the addition of refined” minyak jelantah” (used cooking oil) the lowest value generated was 35.78.

1. Introduction
One of energy sources in Indonesia is coal. It is almost evenly distributed in Indonesia's main islands. The depletion of oil reserves, is estimated to occurin the near term. The Government of Indonesia has decided coal as the main alternative energy source sufficient for the next 200 to 300 years [1]. The default account will eventually leave ash. There are three types of ash resulted from combustion, namely; fly ash, bottom ash, and ash residue in the boiler as slag boilers. There are a number of elements found in fly ash that are potential to become poisons [2]. Ash content in coal ranges from 5% to 30% [3] [4]. Ash and sulfur are elements of impurities (nuisance dirt), in addition to other impurities such as soil, rocks, minerals, and others. As one of the parameters of coal quality, sulfur has become a concern for many parties. Sulfur content in coal, when burnt, will turn into sulfur oxide [5].

This compound can react with water vapor in the air to form H SO. It is condensed in the air and then falls together with rainwater and creates acid rain. The release of sulfur oxides from coal combustion can cause acid rain up to hundreds of kilometers. Sulfur in coal shells can be formed in the form of a mixture of oil and gas. It can be found in the form of a mixture of sulfur and sulfate as well. Sulfur is a stable material in coal organic compounds and is often called organic sulfur which is spread evenly to all coal. Very small amounts of sulfur can be formed as sulfates such as calcium sulfate or iron sulfate. Sulfur levels in coal are vary from very small amounts (traces) to more than 4% [6]. Efforts to reduce ash and sulfur contents in coal, in addition to eliminating pollutants, include an effort to increase coal calorific value to allow it to provide value similar to high-quality coal. Coal is a heterogeneous flammable substance formed from many components that have different mutual characteristics. Coal can be defined
as a sedimentary formed from decomposition of plant stacks for approximately 300 million years. This plant decomposition occurs because of biological processes with microbes where a lot of oxygen in cellulose is altered into carbon dioxide (CO2) and water (H2O). Coal is formed in a very complex manner that takes a long time (tens to millions of years) under the influence of physics, chemistry, or geological conditions. Based on coal quality or level, it can be grouped into: Lignite is a low rank coal where the position of lignite in the level of coal classification is at transition area from the type of peat to coal [7][8]. Lignite is black coal and has a wood-like texture; Subbitumine coal is a transition between lignite and bitumine. This type has black color that high water content, fly substance, and oxygen, low carbon content. This shows that sub-bitumine type is low-level coal; Bitumine is black coal with a good bonding texture; Anthracite is the highest level of coal that has a carbon content of more than 93% and fly substance less than 10%. Anthracite is generally harder, stronger and often shiny black like glass.

Parameters in Coal Analysis are coal proximate analysis. The proximate analysis of coal aims to determine the moisture content of the moisture, including the value of free moisture and total moisture, ash (dust), volatile matters, and fixed carbon. Moisture is the water content in coal while ash (ash) is a non-combustible residual content generally consists of compounds of silica oxide (SiO2), calcium oxide (CaO), carbonate, and other minerals; Volatile matters are the womb coal which is released at high temperatures without the presence of oxygen (eg CxHy, H2, SOx, etc.). Fixed carbon is the fixed carbon content found in coal after volatile matters are separated from coal. The level of fixed carbon is different from the carbon content (C) in the result of ultimate analysis because some carbons bind to form volatile hydrocarbon compounds; Coal calorific value, one parameter that determines the quality of coal is its calorific value, i.e. the number of energy produced per mass unit. Coal calorific value is measured using a device called bomb calorimeter.

2. Method

The type of research used in this study is operation research with quantitative methods or approaches. Operational research (or better known as operation research or quantitative analysis) is a series of mathematical modeling and analysis activities for decision making. Operational research is the application of scientific methods to complex problems that arise in the direction and management of a large system of humans, machines, raw materials, capital in industry, business, government, defense. Operational research is related to the principle of optimization, namely how to use resources (time, effort, cost, etc.) to optimize results. The quantitative method is also called the positivistic method as it is based on the philosophy of positivism. This method is a scientific method because it meets scientific rules, namely concrete/empirical, objective, measurable, rational and systematic. This method is also called the discovery method because it can be found and developed by various new science and technology. This method is also called a quantitative method because the research data is in the form of numbers and the analysis is using statistics.

This method is chemical and physical washing, where sulfur can be separated from coal based on differences in surface tension and by adding a separation medium in the form of liquid. The water-oil agglomeration method is an effective technique for eliminating ash from coal. The agglomeration process can process anthracite, bituminous and subbituminous coal. A solid as an agglomerate is a thick product combined from various sizes of coal particles obtained from the water-oil agglomeration process. Agglomerates consist of small parts of coal that vary in size from 2 mm to very fine particles measuring several micrometers and will have sufficient inherent strength to remain intact. This agglomeration
method can be applied because of the nature of oil-loving (lipophilic) and water-hating (hydrophobic) from the surface of coal. Materials that sink into the water medium and settle are waste materials, while the material that floats on the same media (water) is clean coal with an oil-coated surface.

Sulfur is an inorganic form. It is found on the surface of coal and together with ash are element of impurities. To reduce the ash content in semi-anthracite coal, agglomeration method applied to water-oil mixture. Because coal particles are essentially hydrophobic, they can be made into agglomerates in the form of coal-oil mixtures. On the other hand, hydrophilic mineral particles (which are the source of ash and sulfur content in coal) are not influenced and persisted in water. Because the particles of coal agglomerates are larger than mineral particles, they can be separated. With the presence of oil during washing, the water mixed with ash will no longer be attached to the coal surface.

3. Result and Discussion

3.1 Description of sulfur data.

The existence of sulfur compounds is expected to be as minimal as possible. The ASTM standard stipulates that coal must not have more than 1% sulfur content. Sulfur in the form of pyrite and sulfate is part of the important minerals contained in coal whose amount can still be reduced by washing techniques. Whereas organic sulfur is found in all carbon materials in coal and the amount cannot be reduced by washing techniques. Coal with high sulfur content causes many problems in its utilization. If the coal is burned, sulfur causes corrosion in the kettle and forms a deposit of slagging in the boiler tube. In addition to that, it also causes air pollution. Some of the sulfur will be carried away in the results of coal liquefaction, gasification, and creating coke.

In coal combustion, all organic sulfur and some pyrite sulfur become SO2. This sulfur oxide can then be oxidized to SO3. The sulfur oxides carried by the exhaust gas can react with the melting of the ash attached to the furnace walls and boiler pipes, which causes corrosion. Some SO2 emitted to the air can be oxidized to SO3, which when reacts with water vapor into an acid mist, may cause a decrease in acid rain. In coke, the sulfur content should not exceed 0.6% (Table 1).

| Table 1. Sulfur Data |
|----------------------|
| Coal+minyak jelatah  | Method | Mess | sulfur average |
| Coal                 | ASTM   | 0.2500 | 1.23         |
| Coal + 5ml           | ASTM   | 0.2500 | 0.976        |
| Coal + 10 ml         | ASTM   | 0.2500 | 0.802        |
| Coal + 15ml          | ASTM   | 0.2500 | 0.609        |
| Coal + 20 ml         | ASTM   | 0.2500 | 0.428        |

3.2 Description of ash data.

The experiments conducted by mixing coal and minyak jelatah (used cooking oil) have resulted in a decrease in the value of coal ash, where the more minyak jelatah is added, the lower the value of ash in coal (Table 2).

| Table 2. Ash data |
|------------------|
| 10 gr Coal+Minyak jelatah | Crucible mass | Initial mass | Occation | Method | Ash |
| Coal Original     | 20.0543       | 0.8576       | 13       | coal   | 62.80 |
| Coal + 5ml        | 22.8594       | 0.9951       | 6        | coal   | 45.12 |
| Coal + 10 ml      | 21.4163       | 0.9107       | 10       | coal   | 37.78 |
| Coal +15ml        | 20.3748       | 0.9169       | 9        | coal   | 35.97 |
4. Conclusion

One of the biggest commodities of mining industry in Indonesia is coal. The coal reserved in Indonesia spread out in two main islands, namely Kalimantan and Sumatera. The quality of coal generated from these two Islands varies associated with the sulfur and ash content. The Sulfur and ash content are closely related to the coal quality, where the lower sulfur the higher quality of coal.

This study found that there is an opportunity to reduce the sulfur content by adding some oils. Based on the results of these experiments, the addition of sweet oil, in general, can reduce ash and sulfur levels to a relatively low level. The ash content of sub-bituminous coal can be reduced from 65% to 35% while the sulfur content can be reduced 1.23% of its original value.

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