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The Influence of Kerosene to Increase the Quality of Coal from Bayah South Banten Using UBC Methode

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ABSTRACT

The increasing price and the decreasing stock of fossil fuel nowadays are two factors that make the use of alternative fuel with lower price become necessity. The source of energy that can be used to fill the gap between convensional fossil fuel towards cleaner and renewable energy is Coal. South Banten has a massive stock of coal, around 70% of all the mineral sources in South Banten, but the quality of the coal is low, due to the sulfur content around 2.28 % dry basis and a high water content that lead to the lowest calor content. The aim of this research is to lowering the sulfur and water content of the coal. Upgrading Brown Coal methode is the methode used to reach the aim stated. The research was settle at temperature 150^0 C, pressure 350 kPa, and addition of kerosene as the solvent. The result of the research shows the increasing of calor content and the decreasing sulfur content when the evaporation temperature gradually increased.

Keywords: *Coal, , Fossil Fuel***,** *Sulfur, Upgrading Brown Coal*

1. INTRODUCTION

Energy consumption from fossil fuel has gradually increased these past decades, but the stock gradually decreased. The scarcity of the fossil fuel has pushed the price to untolerable level. On July 2008 it cost 150 US/Barrel, due to the fact that fossil fuel is the non-renewable source of energy. This condition forced the research to find the alternative renewable source, environmentally friendly, and relatively affordable.

Since 1970, oil and gas have become the major exports of Indonesia. But today, Indonesia could only import the fossil fuel from another country, since the product rate was lower than the rate of the consumption. In 2012, fossil fuels were produced only 900 thousands barrel per day, but the consumption could up to 1.6 million barrel per day. Thus, seven hundred million barrel per day has to be supplied by import. When one barrel cost USD 100, the government of Indonesia has to spend USD 70 millions per day or USD 230 billlion per year only for purchasing oil. These facts lead to the research of alternative fuel source in Indonesia that can be renewed.

The government of Indonesia has issued Peraturan Presiden No 5 year 2006 about Bauran Energi Nasional, which stated that 17% of national energy source by the year 2025 comes from new and renewed energy. The national Vision of energy also stated the same thing with even higher percentage, 25% of national energy by the year 2025 comes from new and renewed energy. This regulation has forced the people to diversify the use of source of energy from local area to reduce the use of oil and natural gas. Coal is hydrocarbon fuel that has not been optimally used for the source of energy. Ministry of Energy and Mineral Source of Indonesia issued a data that there are approximately 65.4 billions ton of coal existed, that could supply the need of energy in Indonesia for more than 100 years.

Coal in Indonesia can be found in almost every island of Indonesia. The type and quality would be different, but almost 70% of the coal has low quality. The low quality coal has to be treated prior to the use of the coal as the source of energy to produce more efficient energy.

The aim of this research is to raise the quality of the coal. The coal used in this research was taken from Bayah, a southern area of Banten. There is approximately 13.3 million ton of coal in Bayah that has not been optimally used as the source of energy. But the low quality of the coal from Bayah has to be treated to raise the quality.

Table 1. The characteristics of coal from Indonesia

No	Characteristic	Value	Unit
1	Water content	200	%
2	Caloric value	5100	cal/g
3	Volatile matter	30-60	%
4	Spontaneous burn	High	-

Upgrading Brown Coal is a method used in this research to raise the quality of the coal from Bayah Banten. This method has been successfully tested by Deguchi *et al.*, 1999 and Shigehisa et al., 2000, which raising the caloric value from 3500 cal/g up to 6000 cal/g by reducing the water content.

The next procedure of this research is to converse the coal to synthetic gas using Catalityc Steam Gasification. Coal gasification research by Sharma et.al in 2007 used a high temperature, 1000^0C. Thus, a catalyst is needed to lower the energy for gasification. This research will use catalyst that can be obtained from local area. Kerosene as the catalyst used in this research will also being tested for its influence to raise the caloric content of the coal.

Coal is a type of rock that can be burned, originally come from the fossil of the plant which died thousand years ago. The major components of coal are carbon, hydrogen, and oxygen. Coal has complex physical and chemical properties and can be found in various shapes.

Coal can be mined from the surface of the land to underground. The raw coal from the mine still consist of impurities mineral such as sulphur as a by product of coalification. There are some factors to determine the quality of the coal such as heating value, moisture content, ash content, sulfur content, volatile matter, fixed carbon, porosity and surface are (Sukandarrumidi, 2006).

A layer of low quality coal generally reside near the surface of the earth, thus the cost needed to mine the coal will be low compare to the high quality of coal. The low quality coal not only economically interesting but also has a lot of benefit when it already converse to a high quality coal as a clean fuel for industrial use, transportation, or even housing complex (Daulay et. al., 2007).

Water content in coal can be classified into free water and bonded water. Free water comes from the environment, while bonded water is a chemically bond water inside of the coal which will be different depends on the moisture and the temperature of the coal mine. This type of water content can be reduced by heating the coal to 104 – 110 ^{0}C.

The water content of coal is a factor that can reduce the quality of the coal, because the coal will be heavy to be transported which lead to high cost of transportation, and will affect the process of burning the coal. Reducing free water content should use mechanical treatment while reducing bonded water should use heating treatment (Umar, 2010).

One heating treatment towards the coal to reduce the bonded water called dewatering process, a process that can be classified into two types, reaction type (dewatering process at temperature above 200^0C) and non-reaction type(dewatering process below 200^0C). According to Tsai (1982), endothermic reaction occur when temperature reach 100 -120^0C. At this stage the free water, the physically bond water, and the water trapped inside the pore of the coal will be evaporated. When it reach 150^0 C the tar of the coal will not completely out of the coal, therefore it is necessary to add substances that can cover the surface of the coal to maintain the stability of water content after the process (Tsai, 1982).

Upgrading brown coal (UBC) is a technology to raise the caloric value and reduce the water content of the coal. It is a quite simple process compare to other process because no chemical reaction needed to reduce the water content. Other process such as Hot Water Drying (HWD) and Steam Drying (SD) use high temperature (above 275^0C) and high pressure (5500 kPa). The UBC process is relatively more simple process with temperature between 150 ^{0}C -160 ^{0}C and pressure between 2 -3 atm. Umar (2010) has already done the research to raise the quality of coal from Bunyu East Kalimantan using the three procesess mentioned. The result of the research shows that the water content before upgrading process was 17.41%, and it gets lower to 4.71% using UBC, 3.43% using HWD, and 1.81% using SD. The highest reducing water content achieved by using SD process (up to 89% water lost) and the lowest one achieved using UBC (72.9% water lost). This is due to the fact that UBC process is carried out on the lower temperature than the SD process. Some benefits of using UBC process are as follows

1. Lower temperature and pressure
2. A cleaner coal is produced because the residu of the oil used in the process can be separated and reused
3. Emission of water from UBC using physical dewatering procees.

Upgrading brown coal is a heating and dewatering process from the coal using oil as the media. The media can be classified into light oil (e.g. kerosene) and heavy oil (e.g. asphalt), which was absorbed selectively into the pore of the coal to cover the surface of the coal. Heavy oil was added into light oil in small quantity (around 0,5%). The function of heavy oil was as an additive agent, therefore many benefits will be resulted from this addition such as the raise of caloric value, the decresesing spontaneous burn of the coal, and also make

the coal to have water repellent characteristic. Some additives usually used are starch, molases, and oil residu. In this research, the additive chosen was the substance with low sulfur wax residue (LSWR), an organic substance with slightly the same chemical characteristic with the coal. Similarity in chemical characteristics will make this additive penetrate into the pore of the coal and dry inside it, which will make the coal to be able to store in open air for some longer period (Couch, 1990).

2. METHODS

The material used in this research is natural Coal from Bayah, a paleogen coal with caloric value between 4500-5000 kkal/kg covered with 4.000 m layer and kerosene as the solvent to absorb heavy oil.

The equipment used in this research are a mixer (used to mix the coal and kerosene) evaporation set (used to release impurities such as water and sulphur), decanter (to separate the coal and the solvent).

The first step of the research was preparing the coal by decreasing until 10 mesh and 20 mesh. The process was carried out using Ball Mill in Metalurgy Laboratory of Faculty of Engineering University of Sultan Ageng Tirtayasa. The smaller size coal resulted then continue to be analyzed of proxymate value (total water content, bonded water, ash content, volatile matter, fixed carbon, and total sulphur), ultimate value (carbon, Hydrogen, nitrogen, oxygen, and sulphur), and caloric value.

The Upgrading Brown Coal process was started by mixing the coal and kerosene in the mixer for 30 minutes until it become slurry. Then, another additive (grease oil) was also added to the slurry. The process was continued by dewatering process to release the water out of the slurry. The condition of the dewatering process was set in temperature 130 ^{0}C upto 150^{0}C and pressure 350 Kpa. Next, the process was continued by separating oil and the coal in 130^{0}C and pressure 100 Kpa.

Fig. 1. Evaporation for processing UBC of coal

3. RESULT AND DISCUSSION

3.1 Analyzing of Pre-Upgrading Coal from Bayah

Table 2 shows the sulphur content of the coal exceed the minimum allowed sulphur to be emitted to the atmosphere (< 0,33 % wt) before the UBC process. This condition will make the caloric content lies around 5721 Kcal/Kg. the high sulphur content of the coal will also become a threat to the environment because it can lead to form acid rain the ash content of the coal 26.45% wt also still exceed the minimum level of < 5 % wt.

Table 2. Quality of coal from Bayah Banten

No	Characteristic	Value	Unit
1	Ash Content	24,65	% wt
2	Volatilematter	34,60	% wt
3	Fixed Carbon	40,74	% wt
4	Gross Caloric Value	5721	Kcal/kg
5	Total Sulfur	2,28	% wt
6	Carbon	60,96	% wt
7	Hidrogen	4,5	% wt
8	Nitrogen	1,5	% wt

3.2 The Influence of Evaporation Temperature to Sulphur Content

Fig. 2 shows the influence of temperature of slurry dewatering to the sulphur content of the coal. The highest the tempertature the lowest sulphur content resulted. This could happen because as the temperature raise to release water from the coal, some sulphur would also being released. Pre-upgrading coal consist of 2.28 % wtsulphur, after the UBC process was carried out the sulphur content decrease to reach 1.91 % wt. The temperature is set below 200 ^{0}C to avoid any chemical reaction occur in the process.

3.3 The Influence of Evaporation Temperature to Fixed Carbon Content of The Coal

Fig. 3 shows the fixed carbon content of the coal from Bayah increased along with the increasing temperature. This is due to the fact that raising temperature will release more water and impurities. The more heat would also lead to a wider porosity of the coal thus releasing more water and impurities lead to increasing carbon content of the coal. Then, kerosene and asphalt replaced water and impurities inside the pore of the coal, also to avoid water to reabsorb to the pore.

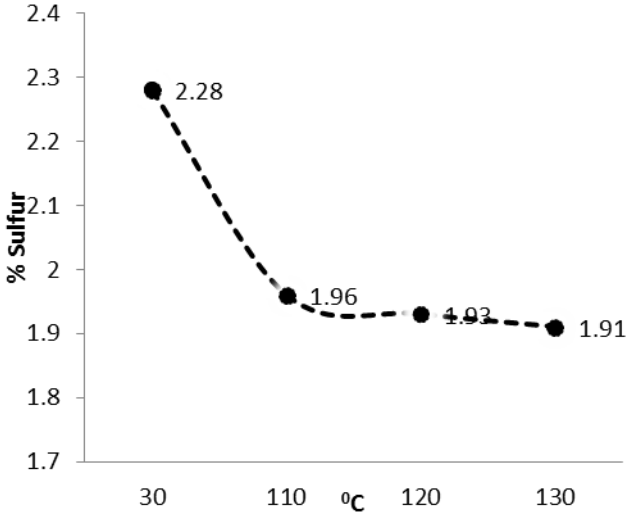

Fig. 2. The influence of evaporation temperature to sulphur content

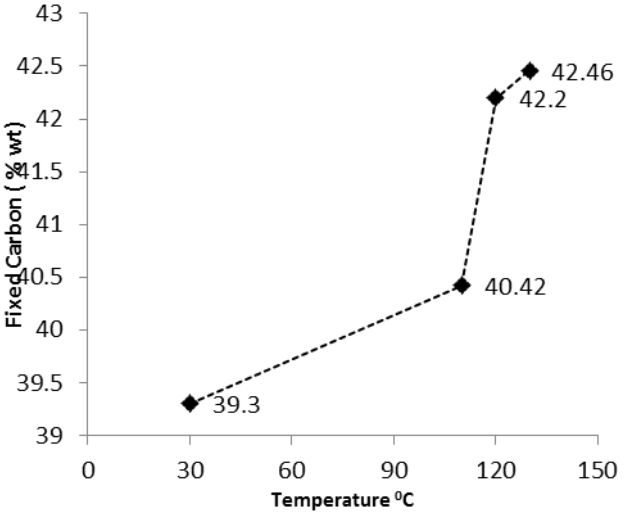

Fig. 3. The Influence of evaporation temperature to fixed carbon content of the coal

3.4 The Influence of Evaporation Temperature to Caloric Value of the Coal

Fig. 4 shows the increasing caloric value with UBC process along with the increasing evaporation temperature. This is due to the fact that increasing temperature reducing the water content and raising the fixed carbon content. The more fixed carbon in the coal would increase the caloric value of the coal. The raise of temperature also allows kerosene and asphalt to penetrate into the pore and fulfill the space inside the pore, thus avoiding any water molecule to reabsorb into the pore.

The UBC process has some special characteristic, such as the moderate drying condition between $140\sim180^0$ Celsius and pressure 350kPa (at this condition no chemical reaction occur therefore the waste water would be easily treated), lower energy consumption of the process because the process use latent calor from the coal to heat the slurry, and oil absorpsion into the pore of the coal would stabilize the coal and reduce the spontaneous burn.

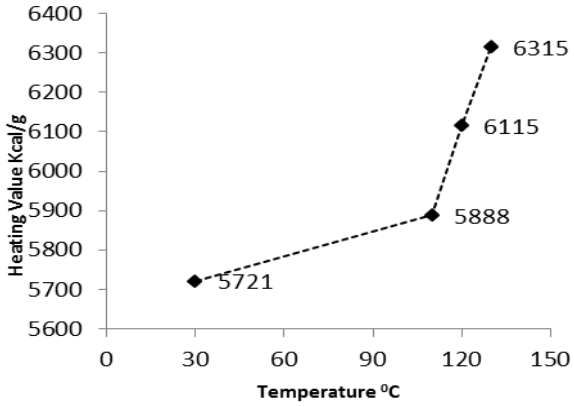

Fig. 4. The influence of evaporation temperature to caloric value of the coal

3.5 The Influence of Evaporation Temperature to Ash Content of the Coal from Bayah

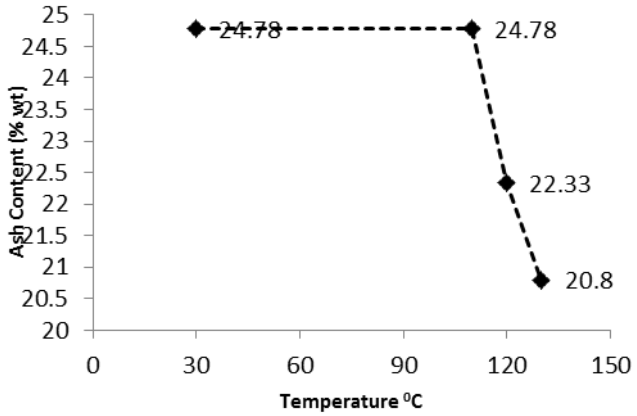

Fig. 5. The influence of evaporation temperature to ash content of the coal from Bayah

Fig. 5 shows the decreasing of ash content of the coal after the UBC process was carried out. The more temperature resulted to the lower ash content. This

could happen because the more heat lead to evaporate more impurities.

4. CONCLUSION

From the result of this research can be concluded that:

1. The increasing evaporation temperature will increase the fixed carbon content and caloric value meanwhile the process also will reduce the sulphur content and ash content of the coal from Bayah Banten
2. The addition of kerosene and asphalt will fulfill the space inside the pore and avoid water to reabsorb to the pore of the coal.

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