Low Grade Coal Quality With Up Graded Brown Coal Technology

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ABSTRACT

The aim of this research is to increase the calorific value of coal. In this way, coal which has a calorific value of 3500 kCal/kg can be increased to 6500-7000 kCal/kg. Apart from that, by carrying out this up grading, a number of volatile meters will disappear as a result of the heating and pressure process. The knock-on impact is an increase in the economic value of coal and thus the selling price will be more competitive. After the data was collected, the data was analyzed using descriptive methods. The descriptive method is used to describe the upgraded brown coal (UBC) process. Findings that can be obtained in this research include: 1) Potential company profits can be increased, 2) Increased local government income through taxes, 3) Many mining areas can be exploited, 4) Reduction of unemployment by expanding employment opportunities in the mining sector, 5) Reducing environmental damage by mining power by mining wisely. 6) Reducing environmental pollution due to the combustion process. 7) With this process, investment in the coal mining sector can be increased. This research concludes that the economic value of low quality coal will increase and the profits that can be obtained will be better.

INTRODUCTION

Coal is a combustible rock of which more than 50% -70% by volume is organic material which is carbon material including inherent moisture. The main organic material is plants which can be traces of tree bark, leaves, roots, wood structures, spores, pollen, resin, etc. Furthermore, the organic material experiences various levels of decay (decomposition), causing changes in physical and chemical properties, both before and after being covered by other sediments. The coal formation process consists of two stages, namely the biochemical stage (peating) and the geochemical stage (coalizing) (Smith et al., 2017).

The peatification stage is the stage where the accumulated plant remains are stored in reduced conditions in swamp areas with poor drainage systems and are always flooded at a depth of 0.5 – 10 meters. This rotting plant material releases H, N, O, and C in the form of CO_2, H_2O, and NH_3 compounds to become humus. Furthermore, anaerobic bacteria and fungi are converted into peat (Stach, 1982, op cit Susilawati 1992).

The coalification stage is a combination of biological, chemical and physical processes that occur due to the influence of loading from the covering sediment, temperature, pressure and time on the organic components of the peat (Stach, 1982, op cit Susilawati 1992). At this stage the percentage of carbon will increase, while the percentage of hydrogen and oxygen will decrease (Fischer, 1927, op cit Susilawati 1992). This process will produce coal in various levels of organic material maturity ranging from lignite, sub bituminous, bituminous, semi anthracite, anthracite, to meta anthracite (Novita et al., 2021).

Coal can be differentiated into 3 characters, namely: 1) Based on the type of coal: what is meant by type of coal is coal as seen from the material from which it is made. For example, coal that is formed in hilly or highland areas has different qualities compared to coal that is formed in lowland areas or swamp areas. 2) Based on coal rank: what is meant by coal rank is the stage of the process of maturation or degree of coalification of coal using a geochemical process, namely from peat to lignate then bituminous and ending with anthracite and meta anthracite, where at each stage there is an increase in carbon value and a decrease water content contained. 3) Based on coal grade: what is meant by grade of coal is the difference in coal based on the content of inorganic impurities trapped in the coal rock, which is called mineral metre. The higher the mineral meter content, the lower the coal grade. With increasing world demand, energy commodities have become an expensive item. On the other hand, petroleum as one of the energy sources that is in great demand is experiencing a decline in reserves. Currently, Indonesia's coal reserves are still quite large, around 120 years old. Because it can be used as a substitute for fuel oil to meet current national needs which have reached 85.6 million kilo liters per year. OPEC, as the world's largest oil producer, only has a world oil market share of 40 percent, therefore OPEC cannot fully control world oil prices (Fitriawan et al., 2018).

In line with increasing demand and tight world oil production, the price of oil on the world market in the fourth quarter of 2005, according to estimates by Indonesian oil observer, Dr Kurtubi, could reach 60 US dollars per barrel. And this is proven by the current increase in oil prices which are approaching US\$ 80/barrel. This happens due to fundamental factors where world oil demand is very high. It is estimated that world demand will reach 84 million barrels per day. The

high demand for oil in these years is due to the continued high demand for oil from China, which has recently been followed by India. Therefore, many countries are trying to divert sources to other forms. One option is coal (Masturoh & Anggita, 2018).

According to expert calculations, world coal reserves are still very large and Indonesia is one of them. It is estimated that Indonesia's coal reserves reach 53 billion tons, which is equivalent to 120 years of current Indonesian coal production. Indonesia is a country that has coal and is currently starting to increase the use of coal to replace petroleum as an energy source. From the research results of the Indonesian Department of Energy and Mineral Resources, it is estimated that Indonesia's coal reserves reach 53 billion tons, spread from Sabang to Merauke (Papua).

Of Indonesia's total coal reserves, the majority is low quality coal (low rank coal). This is a problem in coal in Indonesia because it is less economical to exploit. This is because low quality coal only has a heat content of 3500 kCal/kg because the water content (inhern moisture) is still high, namely 23-30% w/w. Because many places where coal is converted into energy are located far from mining areas, transportation is required (Aswan et al., 2019). Because the water content of low quality coal reaches 40%, almost half of the transportation costs are for transporting water. For this reason, water should not be included in transportation costs. The following are the characteristics of Indonesian low quality coal: 1) High water content, 2) High oxygen content, 3) High hydrogen content, 4) Lots of combustion ash, 5) Lots of volatile metres. All of the above properties cause coal to be more difficult to burn and emit more CO_2.
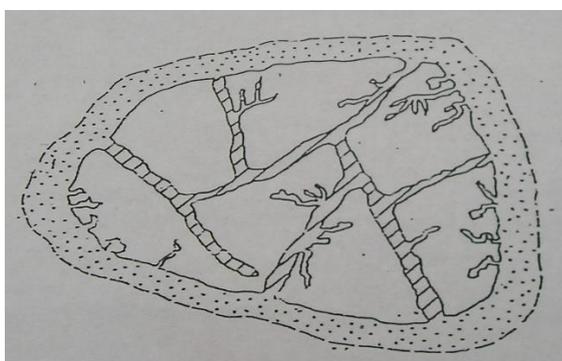
Picture. Low quality coal (low rank coal) which is still dirty

Low quality coal from South Sumatra which has been researched by PTBA and Tekmira Bandung has the following characteristics: 1) Water content 40% (Inhern Moister 23 -30%), Ash (dust) 4 - 10%, 2) Sulfur (sulfur) 0.1 – 0.2%, 3) Calorific Value 3500 – 4800 kCal/Kg. Due to its low calorific value and high water content, the selling value of low quality coal is also low. This is one of the many factors that makes investment in the mining sector, especially coal, less promising than petroleum. The main cause of the low calorific value of coal is the high water content of up to 40% w/w for lignite. In order for the calorific value to increase, the amount of water content, especially internal moisture, can be reduced.

LITERATURE REVIEW

The oldest coal of Middle Hurorian age from Michigan comes from algae and fungi. Meanwhile, during the Lower and Upper Devonian era, coal mostly came from Psilophites (such as Taeniocrada decheniana (lower Devon)). Most coal from this era has an average of thin seams (3-4m) and has no economic value. In the Upper Carboniferous, plants started to get taller, reaching a height of more than 30m, but were not as diverse as now. At this time it is dominated by: Lepidodendron, Sigillaria, Leginopteris oldhamia, Calamitea. The Upper Carboniferous Era is known as the bituminous coal period. Important layers of Permian coal are found in the USSR, predominantly formed from Gymnosperm cordaites. In the Mesozoic era, especially the Jurassic and Lower Cretaceous, Gymnosperms (Ginkcophyta, Cycadophyta and Cornifers) were important coal-forming plants, especially in Siberia and Central Asia. In swamps of Upper Cretaceous and Tertiary age, angiosperm plants grew rapidly in N. America, Europe, Japan and Australia (Ainiyah et al., 2022).

When compared with plants during the Carboniferous period, plants during the Mesozoic era, especially the Tertiary era, were more diverse and specific and produced thick peat deposits and varied in facies types. Coal is an organic sediment, more precisely an organic rock, consisting of various pseudominerals. Coal is formed from rotting plant remains and collects in areas with lots of water, usually called swamps. This condition inhibits the complete decomposition of plant remains which then undergo the process of turning into coal. Apart from the variety of plants found, the level of maturity also varies, because it is influenced by local conditions. These local conditions are usually oxygen content, acidity levels, and the presence of microbes. In general, these plant remains can be in the form of trees, algae, moss, flowers, and plants that usually live in swamps. The type of flora found in a coal seam depends on local climatic conditions. In the same deposit, the analytical properties found can be different, not only because the plant of origin may be different, but also because of the many chemical reactions that influence the maturity of a coal (T. Khurrahman et al., 2019).

In general, after the plant remains are collected in certain favorable conditions (lots of water), the formation of peat (peat) generally occurs. In this case, peat is not included in the coal group, but the formation of peat is the initial stage of coal formation. The process of coal formation itself can briefly be defined as a change in existing plant remains, starting from the formation of peat (peatification) then lignite and becoming various grades of coal, also known as the coalification process, which then turns into anthracite. The formation of coal greatly determines the quality of the coal, where the process that takes place, apart from involving the metamorphosis of plant remains, also depends on the conditions at that geological time and local conditions such as climate and pressure. So the formation of coal takes place by the accumulation of plant remains which results in changes such as enrichment of carbon elements, alteration, reduction of water content. In the initial stages the influence of microorganisms also plays a very important role (Kasim & Prabowo, 2017) and (Cholilalah, Rois Arifin, 1967)

METHOD

In preparing this paper, data was collected from magazines, books about energy, internet sites, and notes in the Energy Diversification course. After the data was collected, the data was analyzed using descriptive methods. The descriptive method is used to describe the upgraded brown coal (UBC) process.

RESULT

60-65% of the coal found in Indonesia is low quality coal, and in order to increase the calorific value it is necessary to reduce the water content (inherent moisture) until the remaining 5% w/w. In this case the author limits the problem by using low quality coal raw material from Banko to be up graded with a heating process of up to 160 C and pressure of up to 350 kPa. The final result of this up grading process is powder which can then be made into other forms. The mixing fluid used is kerosene (kerosine) which is added with oil recovered from the separator. This mixture is useful for forming a slurry which will cause the pores from which the water has been released to be closed by oil (Putri & Fadhillah, 2020), (Alhogbi et al., 2018) and (Smith et al., 2017).

DISCUSSION

From the raw material that will be processed after research, it turns out that from the three comparison samples it is clear that coal from Bangkok has a shorter time to achieve the desired results with the UBC process.

A. Stages of the Up Grading Process

The UBC process uses kerosene to form a slurry. From this slurry, by heating and pressure the inherent moisture will be reduced. The higher the heating temperature, the greater the reduction in inherent moisture. The following is a graph of temperature versus water reduction. And what about warm-up time. It turns out that the heating time also affects the reduction of water contained in coal. This can be seen in the image below.

Stage I. Cleaning (Cleaning)

After the coal is exploited from the mining location and placed in a stacking location. Dust, soil and other impurities must be avoided so that the coal does not become dirty. Therefore, the coal needs to be cleaned or washed so that the coal to be processed is clean from external dirt attached to it. And to dry the external water resulting from washing, the coal needs to be passed in an oven using waste heat in the UpGrading Brown Coal process.

Stage II. Scouring

Clean and dry coal is crushed or milled in stages to obtain the desired final size, which is around 3 mm. The coal that has been crushed is then filtered for each grinding level. Material that does not pass the filter will be ground again until it meets its size. So that the final grinding (crushing) has a size of no bigger than 3 mm. Next, the granules/powder are ready to be mixed with oil at the slurry making place.

Stage III. Slurry making

From the crushing point, the coal that has reached the size in the mixer is mixed with oil in a certain ratio until it becomes a slurry (mud). The oil used is kerosene plus oil recovered from the separation between oil and slurry in the separation process. The result of this mixing is a thick, dark colored slurry. Once it is completely flat, using a scrow transporter, the slurry is put into a heating area to reduce the water content.

Stage IV. Dewatering slurry

In this heating location, the reduction of the water content of the slurry is carried out by heating at a temperature of 150-160 C and at a pressure of 350 kPa. With this treatment, the water and oil content in the coal will evaporate. By evaporating the water contained in coal (inherent moisture), the inhibiting factor for coal having a good calorific value will be reduced. In this way, the calorific value of coal increases from 3500 kCal/kg to 6500-7000 kCal/kg. The resulting steam is condensed so that it becomes liquid again.

The resulting liquid is a mixture of water and oil. Then the oil and water are separated. The water can be thrown away and the oil can be used again to make slurry.

Stage V. Separation

The waste heat from the water reduction process is used to separate the oil from the slurry. This process is carried out at a temperature of 130 C and a pressure of 100 kPa, the excess oil in the slurry will evaporate so that the slurry becomes less sticky to each other or is called less oil. At this point the coal produced is in the form of granules but is still somewhat sticky to each other because it is wet.

Stage VI. Drying

With the drying process at a temperature of 130 C and a pressure of 100 kPa, the coal granules which were previously still sticky to each other can be separated easily. And the results can be saved to be made according to needs. In this way, the process of Up Grade coal from 3500 k Cal/kg to 6500-7000 kCal/kg is completed with the result being powder, which can then be processed for certain purposes. From the process stages above, better quality coal is obtained with a calorific content reaching 7000 kCal/kg. The form of coal that has been upgraded is as below. Image: coal upgrading process.

Table 1: Coal upgrading results after proximate analysis obtained results as below.

Analysis Item	Raw Coal	UBC
Total moisture %	33,6	0,4
Equilibirium Moistute %	20,7	9,8
Spesific Energy		
Gross as received	4540 kCal/kg	6990 kCal/kg
Gross as air dried	5420 kCal/kg	6490 kCal/kg
Ash %	2,5	2,7
Volatile metter % db	51,2	52,5
Sulfur % db	0,48	0,49

Source: Researcher data processing

B. Up Grading Costs

By following the process carried out in the pilot project for up grading brown coal in Palimanan which uses a kerosene catalyst plus oil recovered from the up grading process in the separator and rayer, a process cost of US$ 8.8/ton for production of 5000 tons of briquettes per day is obtained (Saud et al., 2018) and (Lin & Wu, 2016). This cost includes all operating costs, including electricity and employee salaries. With up grading costs of US$ 8.8/ton, after adding the low quality coal price of US$ 10-15/ton, after processing the initial price only reaches US$ 20-25/ton. Below is a table of costs for building the UBC pilot project factory in Palimanan.

Table 2: Point costs for building and operating the UBC factory

No	Economic Parameters	Mark
1	Factory Construction Costs (million US$)	82
2	Construction Period (years)	3
3	UBC Briquette Production (tons/day)	5
4	Initial coal price (US$/ton)	13
5	Production costs (US$/ton)	8,8
6	Depreciation (years)	15
7	Debt repayment period (years)	15
8	Equity ratio (%)	25
9	Corporate tax (%)	30

Source: Researcher data processing

CONCLUSION

By carrying out the Up Grade process, the calorific value of low quality coal can be increased from 3500 kCal/kg to 6500-7000 kCal/kg. This will clearly improve the economic value of low quality coal. Besides that, the process of producing energy will not produce excessive pollution of the air. increasing helps reduce the contribution of air pollution caused by burning coal. Meanwhile, the economic value of low quality coal increases and the profits that can be obtained will be better.

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