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ANALYSIS OF COAL QUALITY IMPROVEMENT USING CHEMICAL METHODS FOR MEETS STANDARDS OF CALORIFIC VALUE

N Nahar[1], Ridwan[1*], Irwan[1], Pardi[1]
[1]Chemical Engineering, Lhokseumawe State Polytechnic, Jl. Banda Aceh-Medan Km. 280.3, Buketrata, Mosque Punteut, Blang Mangat, Lhokseumawe City, Aceh 24301, Indonesia
Email: ridwan.kimia@pnl.ac.id

ABSTRACT

As a country with relatively large coal resources and reserves, Indonesia will face challenges that are not easy in the future. The large amount of coal resources and reserves as well as the continuity of the coal mining industry cannot be ignored. Coal consumption in the world is expected to continue from time to time, especially in the Asian region. Lignite coal reserves account for around 48% of total coal reserves in the world, meanwhile in Asia lignite coal reserves reach 30%, while in Indonesia they reach 60% of total coal reserves. Although the amount of lignite coal consumed accounts for around 30% of total world coal production. The amount consumed in Asia accounts for only 10% of its total coal production. Especially in Indonesia, mining practices tend to tend to be higher quality bituminous and sub-bituminous coal which is more widely mined and produced because producing lignite coal is less economical and cannot meet market criteria. Thus, it can be predicted that what will remain in the future will be a large amount of lignite coal reserves that cannot be utilized. Because the opportunity to fill the potential of the coal market is still wide open, whether used directly as an energy source in power plants or exported abroad, promotion of the use of lignite coal must be made as early as possible as a very important issue for Indonesia. To improve the quality of lignite coal to coal whose quality is like that of anthracite coal so that it can be used, therefore it is necessary to have technology to improve the quality of lignite coal, so the Industrial Innovation Research research will improve the quality of coal using the stirring method by varying the influence of temperature and mixing time. coal, residual oil and kerosene can reduce the water content contained in low rank coal by the adsorption process. The research results show that operating conditions greatly influence the distribution of coal products. Relatively good operating conditions were obtained at a temperature of 200o C and a reaction time of 70 minutes with the results of: oil: 25 ml, water content: 0.668%, ash content: 11.883%, volatile matter: 30.122%, fixed carbon: 57.377%, and calorific value : 6581 Kcal/kg.

***Key words**: Coal; Quality; Kerosene; Calorific Value; Enhancement*

1. INTRODUCTION

1.1 Background

Coal consumption in the world is expected to continue from time to time, especially in the Asian region. Lignite coal reserves account for around 48% of total coal reserves in the world, meanwhile in Asia lignite coal reserves reach 30%, while in Indonesia they reach 60% of total coal reserves. Although the amount of lignite coal consumed accounts for around 30% of total world coal production. The amount consumed in Asia accounts for only 10% of its total coal production. Especially in Indonesia, mining practices tend to tend to be higher quality bituminous and sub-bituminous coal which is more widely mined and produced because producing lignite coal is less economical and cannot meet market criteria. Thus, it can be predicted that what will remain in the future will be a large amount of lignite coal reserves that cannot be utilized. Because the opportunity to fill the potential of the coal market is still wide open, whether used directly as an energy source in power plants or exported abroad, promotion of the use of lignite coal must be made as early as possible as a very important issue for Indonesia. To increase the quality of lignite coal to coal whose quality is like that of anthracite coal so that it can be used, therefore it is necessary to have technology to improve the quality of lignite coal.

Coal is one of the energy resources that is abundant on earth, Indonesia is one of the largest coal producers in the world after China, USA, India and Australia. Indonesia's coal production in 2014 reached 470.8 million tonnes out of total available resources of 124.8 billion tonnes. In 2015, Indonesia's coal resources increased by 1.8 billion tons with total reserves of 32.26 billion tons. Of the total coal resources and reserves, around 50% is on the island of Sumatra, 49.5% on the island of Kalimantan, and the rest is spread across the island of Java. These coal resources and reserves are dominated by low to medium calorie coal, namely 27.11% is low calorie coal (lignite) and 63.99% is medium calorie coal (Bituminous) (Ministry of Energy and Mineral Resources, 2019).

Indonesian low rank coal generally contains a water content of around 20% to 40%, resulting in high handling and transportation costs and low calorific value. Despite these shortcomings, this coal has advantages in the form of low ash and sulfur content. In addition, the proximity of coal deposits to the surface results in low production costs.

Improving the quality of low rank coal can be done through the Upgraded Brown Coal (UBC) process, which is a process that can reduce the water content in coal. This process is a development from the initial processing of coal to the coal liquefaction process, so that it can produce clean coal with high calories, water content and low pollution. This quality improvement will save costs on installing pollution prevention equipment at PLTUs and other industries that are accustomed to using high/medium calorie coal.

Indonesia's coal resource reserves, the economic aspect of which has not been taken into account, in 2009 reached 104.76 billion tons (as of January 1 2009), of which 50% is spread across Sumatra (the largest in South Sumatra) and 50% in Kalimantan. Most of Indonesia's coal potential falls into the young coal or low rank coal category, with an estimate of 58.7% lignite, 26.7% sub-bituminous, 14.35% bituminous and 0.3% anthracite (CDIEMR, 2009). Presidential Decree No. 5 of 2006, which states that coal consumption will continue to increase until 2025, creating a large and growing market opportunity for low rank coal.

One of the biggest uses of coal in Indonesia is as fuel for Steam Power Plants (PLTU). It can be seen in Figure 1. It can be observed that the use of low rank coal is mostly for electricity generation.

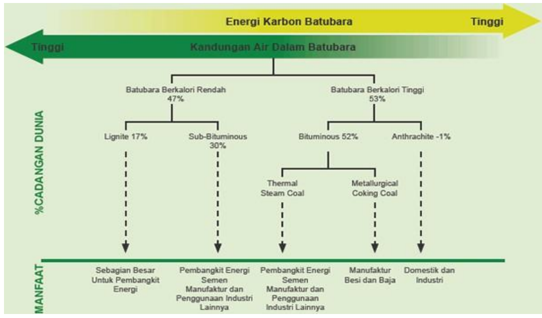

Figure 1. Utilization of coal

Table 1. SNI for Coal and Minister of Energy and Mineral Resources Regulation as follows:

No	Characteristics	SNI-01-6325-2000	ESDM Ministerial Regulation No. 047 of 2006 (Burnt Stone Briquettes)
1	Water content (%)	Maks 8	Maks 15
2	Calorific Value (cal/g)	5.000	4.400
3	Ash Content (%)	Maks 8	<10
4	Compressive Strength (kg/cm2)	-	65

This research was carried out at the Lhokseumawe State Polytechnic Chemical Engineering Laboratory. The selection is based on the availability of places for research and calculating the amount of coal ash which the mixing tool (Agitator).

2. RESEARCH OF METHODE

The product that is produced is quality coal that is high in calorific value by using the method of mixing kerosene and residual oil using the working principle of mixing (stirring).

2.1 Materials used

The material used in this research is coal from mines in Nagan Raya Regency, Aceh Indonesia at PT. Quantum Energy by using residual oil. Whereas kerosene is used as a solvent.

2.2 Tools used

The equipment used in this research includes a set of tank equipment with a stirrer that is placed on a heater with a predetermined temperature and time.

Figure 2. A set of stirred reactors

The set conditions are, the amount of coal is 100 gr, coal size Coal size = 20 mesh, stirring = 100 rpm, kerosene volume = 100 cc, residual oil volume = 100 cc, mixture comparison (coal: kerosene: residual oil) = 1 : 1 : 1. Operating conditions of material mixture temperature (oC) = 120; 140; 160; 180; 200. Mixing time (minutes) = 30; 40; 50; 60; 70.

2.3 Materials

Coal is cleaned of impurities in order to get good results, then dried in the sun until dry.

Figure 3. Coal refined to 20 mesh

3. DISCUSSION

The coal that has been dried is refined up to the size of 20 mesh to get a uniform size and then weighed according to the comparison of the composition of the material. Coal, residual oil and kerosene are mixed using a mixer in this case a tank with a stirrer at a speed of 100 rpm. This mixing or stirring is done so that the adsorption process occurs in the three compositions of the material. Mixing in a stirred tank with a predetermined temperature and time. Then the product is filtered, dried and analyzed for water content, calorific value, ash content, fixed carbon, and volatile matter. While the filtrate in the form of oil can be reused (recycled).

Table 2. Results of Observational Data Mixture of coal deposits with oil at various temperatures and times.

Suhu °C	Waktu	Batu bara (gram)	Minyak (ml)
120	30	123,10	125
	40	128,76	117
	50	128,71	97
	60	131,41	81
	70	127,95	75
140	30	119,81	105
	40	118,08	95
	50	129,05	91
	60	124,06	50
	70	131,60	48
160	30	130,74	97
	40	127,06	90
	50	137,46	85
	60	135,90	75
	70	132,50	50
180	30	135,24	85
	40	135,95	95
	50	132,38	65
	60	130,72	65
	70	129,34	40
200	30	133,35	81
	40	132,01	80
	50	133,28	65
	60	121,95	65
	70	131,03	25

Table 3. Results of Proximate Analysis of deposits of a mixture of coal, kerosene and residual oil at various temperatures and times.

Suhu °C	Waktu	Kadar Air	Kadar Abu	Kadar Volatile Matter (%)	Kadar Fixed Carbon (%)	Nilai Kalor (Kcal/Kg)
120	30	1,321	5,633	51,54	41,502	
	40	1,233	6,997	47,97	43,794	
	50	1,198	8,905	43,73	46,159	
	60	1,153	10,06	38,13	50,709	
	70	1,098	10,52	36,46	51,876	4816
140	30	1,214	6,365	50,44	41,976	
	40	1,132	7,998	46,58	44,287	
	50	0,993	9,205	42,94	46,856	
	60	0,903	10,32	37,91	50,857	
	70	0,806	10,77	34,97	53,447	5228
160	30	1,153	7,767	48,23	42,757	
	40	0,986	8,453	45,75	44,828	
	50	0,861	9,537	41,95	47,649	
	60	0,803	10,53	36,77	51,889	
	70	0,741	11,13	33,84	54,277	5750
180	30	1,142	8,355	47,21	43,286	
	40	0,968	8,782	44,94	45,302	
	50	0,853	10	41,01	48,129	
	60	0,804	10,78	35,10	53,312	
	70	0,732	11,57	31,38	56,316	6320
200	30	1,105	9,387	45,84	43,661	
	40	0,953	8,545	42,66	47,833	
	50	0,847	10,325	96,60	49,228	
	60	0,776	10,989	33,31	54,913	
	70	0,692	11,245	30,78	57,266	6581

Analysis of Fixed Carbon Rates

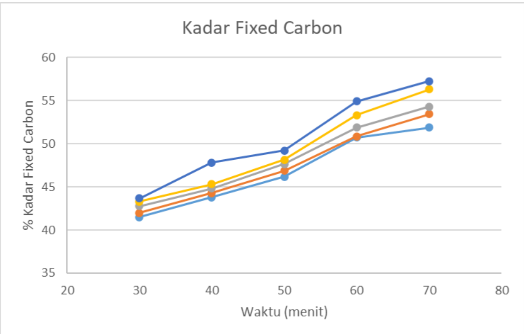

Figure 4. Fixed Carbon Analysis Graph

From the results of the coal analysis, there is a relationship between temperature and time on the level of fixed carbon. The higher the adsorption temperature, the higher the fixed carbon. This is because the residual oil consists of quite a lot of hydrocarbon groups and heteroatoms, [Suwandi, 2017] and the influence of the higher the adsorption temperature, some of the hydrocarbons and heteroatoms are released to form carbon compounds so that it can increase the level of fixed carbon. It can be seen in the picture, that the highest fixed carbon is 57,266% at a temperature of 200° C and a time of 70 minutes.

Calorific Value Analysis

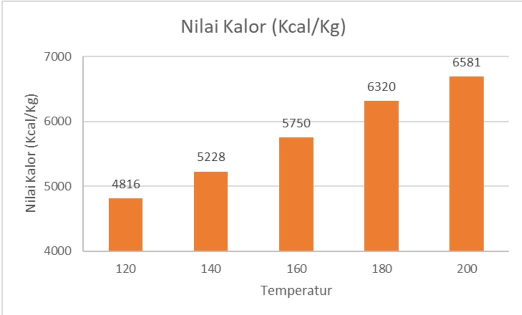

Figure 5. Effect of temperature on calorific value

From Picture 5 in can be seen that the higher the temperature of mixing the ingredients, the higher the calorific value. This is because in that situation there is a release of organic compounds (volatile matter), water levels and ash levels are decreasing and fixed carbon is increasing which will increase the calorific value. The highest calorific value is found at a temperature of 200° C and a time of 70 minutes, with a value of 6581 Kcal/kg.

This research was carried out at the Lhokseumawe State Polytechnic Chemical Engineering Laboratory. The selection is based on the availability of places for research and calculating the amount of coal ash which the mixing tool (Agitator).

4. CONCLUSION

Based on the results obtained in this research, it can be concluded as follows:

The temperature and time of the mixture of coal, kerosene and residual oil influence the increase in the calorific value of coal. With the influence of temperature and time, the calorific value of low-level coal was obtained from 4816 kcal/kg to 6581 kcal/kg with the acquisition of water content: 0.692

%, ash content: 11.245 %, volatile matter: 30.788 %, fixed carbon: 57.266 %, In research this obtained an increase in the average calorific value of 17,198%.

5. SUGGESTION

Based on the research and discussion, further research needs to be conducted regarding more complex operating condition variables (reaction temperature and reaction time). Thus, 36 optimum operating conditions were obtained in the coal adsorption process using residual oil solvent and kerosene as a medium.

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