Carbonization and Oil Agglomeration Method as Pretreatment for Coal Briquette

Nukman[1], Taufik Arief[2], Riman Sipahutar[1]

[1)]Mechanical Engineering Department
[2)] Mining Engineering, Engineering Faculty
Sriwijaya University

Abstract

The content of CO, SO_2 and NO_x as pollutants which be generated by combustion of coals are basic of this research. The agglomeration method as the way of removing ash sulfur. Fraction coal in certain weight mixed with water and oil to produce agglomerates which is a clean coal can be extracted from them. Direct Combustion Furnace used for carbonization process in this research, which moisture and ash eliminated. The importance of studies are analyzed the elements of coal, the calorific value and analyzed of gas emission CO, SO_2 and NOx.

Keywords: *Briquette, carbonization, agglomerate, calorific value.*

Introduction

Coal briquette is a solid fuel in a certain size, which are consist of small fraction of coal that be compacted with or without binder to make the briquette become solid and easier to use. The using of coal briquette as a fuel in Indonesia has been promoted since 1993 in three territories in Jawa. By now coal briquette has been widely distributed for chicken husbandaries, restaurants, small food industries, dried tobbaco industries, preserved fish industries, et cetera. Because of the gas emission should be minimized and the limitation of the emission, by now briquette has been developed. Another thing that expected of coal briquette development is maximize of the calorific value.

The content of Sulfur Dioxide and Nitrogen Oxide of Indonesia's coal briquette should obey to Indonesia Gas Emission standards and other countries **(Table 1).**

Theory

Agglomeration

Oil agglomeration is an effective technique for recovering and dashing coal fines. Vegetables oil (sun flower and soybean) as coal agglomeration media which used to clean Spanish High Rank coal. This research done by Garsia *et al.* (1996) and

Robbins *et al.* (1992) by using diesel oil, fuel oil and three others oil to clean coals. The coals tested were three different sub bituminous coals and a Texas lignite. Ghani (2000) from LIPI Bandung investigated to remove of Tondongkurah coal ash by oil agglomeration method. He claimed that the finer coal fraction size and the higher of the weight percent of diesel oil corresponded with the higher of decreasing of ash content.

Tabel 1: Indonesian gas emission standards (SO_2 and NO_x) and others countries, (mg/m^3)

Country	SO_2	NOx
Indonesia (< 2000)	1500	1700
Indonesia (> 2000)	750	850
Australia	2000	800
Canada	715	740
European Union	400	650
Germany	400	200
Japan	170 – 800	410-720
Korea	2200	875
New Zealand	125	410
Thailand	1300	940
United Kingdom	400	650
United states	740-1480	615-740

Carbonization

The carbonization process is a method that effect to increase carbon content of coal. This process not only to increase the carbon content, but also to eliminate or decrease the odor or awful smell and smoke which produced of the combustion of coal.

Suyadi (1995) found the increasing the content of fixed carbon, which he used lignite (Air Laya), Sub bituminous (Muara Tiga) and Bituminous (Banko) coals.

In this research, the direct combustion furnace will be used for carbonization process. A drum that we designed before and has been used for preliminary investigation. The process produced semi cokes.

The Influence of Blending

Helle *et al.* (2003) said that, the blending of coal to improve the quality of coals and to increase utilization in power plant. The blending between expensive and the cheaper ones.

Methodology

Carbonization

The temperature on coal combustion process be held on 500^{0}C, and the temperature is measured by a thermocouple. The flow diagram show the operating process. The coals are Semi anthracite and sub bituminous.

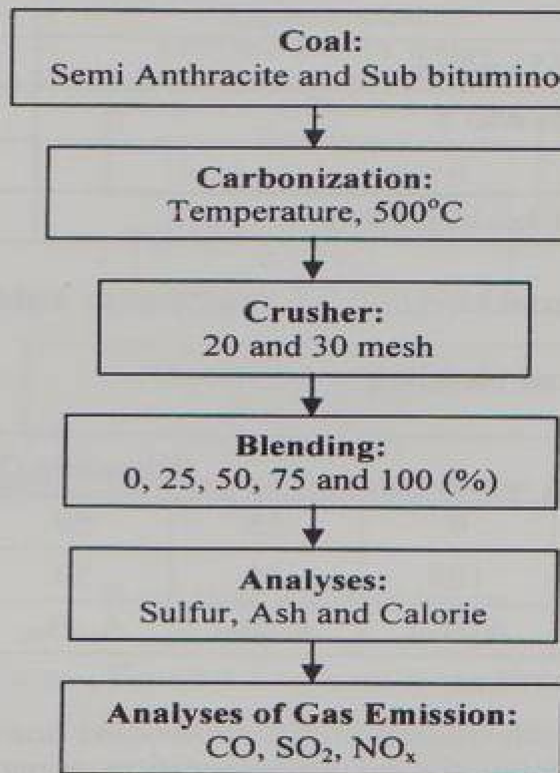


Figure 1. The flow of carbonization process

The Tanjung Enim's coals used in the tests are decribed in **Table 2 and 3.**

Tabel 2. Specification of subbituminous coal

No	Parameter	Value
1	Total moisture (% ar)	25,8
2	Inherent moisture (% adb)	10,2
3	Ash (% adb)	5,5
4	Volatile Matter (% adb)	41,5
5	Fixed Carbon (% adb)	42,8
6	Sulfur (% adb)	0,29
7	Calorific Value (kcal/kg adb)	6124

Tabel 3. Specification of semi anthracite coal

No	Parameter	Value
1	Total Moisture (% ar)	5,3
2	Inherent Moisture (% adb)	1,3
3	Ash (% adb)	6,2
4.	Volatile Matter (% adb)	11,8
5	Fixed Carbon (% adb)	80,7
6	Sulfur (% adb)	1,58
7.	Calorific Value (kcal/kg adb)	8017

The composition of coal blending are described in **Table 4**

Table 4. Composition of coal blending

Coal	Blending (%)				
Semi Anthracite (A)	0	25	50	75	100
Sub bituminous (B)	100	75	50	25	0
Code Name	A_0B_{100}	$A_{25}B_{75}$	$A_{50}B_{50}$	$A_{75}B_{25}$	$A_{100}B_0$

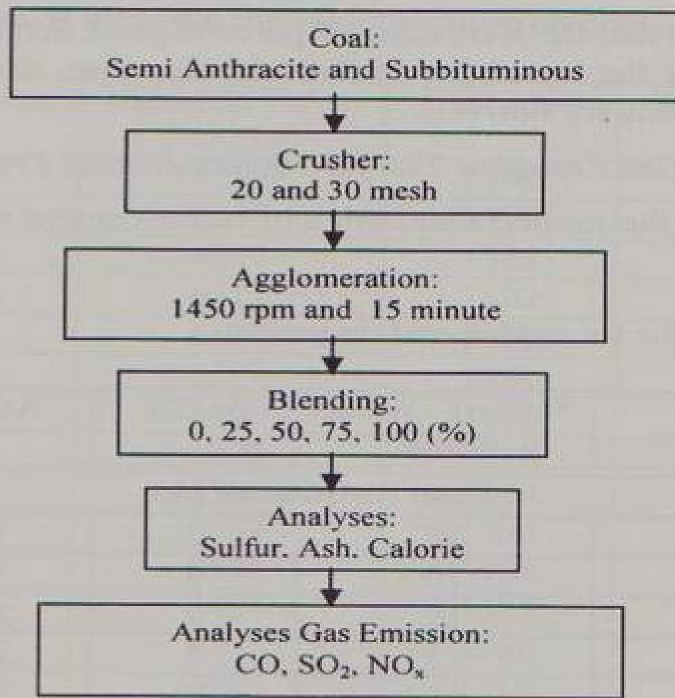
Agglomeration

We have a good design for an agglomeration apparatus. The agglomeration method as the way of removing ash and sulfur. A certain weight percent of oil will be mixed with water and coal fraction to produce agglomerates which is a clean coal can be extracted from them. The speed of the process is on 1450 rpm and will take time in 15 minutes.

The process variables of the research as given in **Table 5.**

Table 5. Agglomeration parameters

No.	Varian	Level	
1	Fraction Size (mesh)	20	30
2	Coal – Water Ratio (grm/grm)	10	15
3	Time (minute)	15	
4	Oil (%)	5	20



Figue 2: The flow of agglomeration process

Result and Discussion

Analyze Values and Emission Test for Carbonization Process.

Table 6: Analyses value and emission test for carbonization process

Code Name	Analyze			Emission Test		
	Ash (%)	Sulfur (%)	Calorific Value (kcal/kg)	CO (ppm)	SO_2 (ppm)	NO_x (ppm)
			Mesh 20			
A_0B_{100}	6,00	0,25	6130	1417	3,06	2,11
$A_{25}B_{75}$	X	X	6141	1418	3,18	3,09
$A_{50}B_{50}$	X	X	6807	1420	4,24	2,89
$A_{75}B_{25}$	X	X	7737	1421	4,31	2,89
$A_{100}B_0$	6,80	1,42	8020	1430	4,72	2,87
			Mesh 30			
A_0B_{100}	1,40	1,20	6130	1417	3,06	2,10
$A_{25}B_{75}$	X	X	6140	1418	3,16	3,08
$A_{50}B_{50}$	X	X	6800	1422	4,26	2,89
$A_{75}B_{25}$	X	X	7737	1421	4,31	2,88
$A_{100}B_0$	4,80	1,20	8020	1434	4,74	2,88

The table show that the increasing of percentage of Semi anthracite on the coal blending, followed by the increasing of the calorific value, even so for gas emission CO and SO_2, on the contrary for NO_x.

Analyses Value and Gas Emission Test for Agglomeration Process

For the reason the limited time, ash and sulfur content for coal blending could not be analyzed.

Tabel 7. Ash and sulfur for agglomeration process

No.	Fraction (Mesh)	% Coal –Water Ratio	% Oil	Ash (%)	Sulfur (%)
Semi Anthracite (A)					
1	20	10	5	3,90	0,9
2	30	10	5	3,90	0,7
3	20	15	5	2,70	0,6
4	30	15	5	2,60	0,6
5	20	10	20	3,00	0,9
6	30	10	20	2,80	0,9
7	20	15	20	3,10	0,7
8	30	15	20	3,10	0,7
Subbituminous (B)					
9	20	10	5	1,00	0,24
10	30	10	5	1,00	0,23
11	20	15	5	1,00	0,23
12	30	15	5	0,90	0,21
13	20	10	20	0,90	0,21
14	30	10	20	0,90	0,20
15	20	15	20	0,70	0,20
16	30	15	20	0,90	0,20

Table 7 show that for Semi anthracite, the percentage of the decreasing ash is a significant amount. The low ash content is about 2.60% (6.20 – 2.60 = 3.60% decrease) for fraction size 30 mesh, in coal - water ratio 15% and 5% oil.

Whereas for sub bituminous, the low ash content is 2.90% (5.50 – 2.90 = 2.60% decrease). The low sulfur content of sub bituminous is 0.60% for fraction size 30 mesh, for coal - water ratio 15% and 5% oil. Whereas for semi anthracite, low sulfur content is 0.20% for fraction size 30 mesh, for coal - water ratio 10% and 20% oil.

The Effect of Blending for Agglomeration Process.

The test for this coal blending are in fifty-fifty percent in weight (semi anthracite/sub bituminous). The meaning of code name A_2B_9 are A_2 semi anthracite on fraction size 20 mesh and 15% for coal - water ratio and 5% oil: B_9 is sub bituminous on fraction size 20 mesh, and coal - water ratio 10% and 5% oil.

Table 8. The effect of blending for agglomeration process.

No	Code-name	Calorific Value (kcal/kg)	CO (ppm)	SO_2 (ppm)	NO_x (ppm)
1	A_1B_9	6275	1398	3,00	2,85
2	A_1B_{10}	6280	1390	3,64	3,02
3	A_1B_{11}	6300	1388	3,88	3,18
4	A_1B_{12}	6314	1402	4,24	3,24
5	A_1B_{13}	6250	1420	4,00	2,98
6	A_1B_{14}	6275	1390	3,66	3,00
7	A_1B_{15}	6700	1388	3,98	3,11
8	A_1B_{16}	6400	1378	4,00	3,24
9	A_2B_9	6502	1399	4,20	3,21
10	A_2B_{10}	6664	1400	3,10	3,21
11	A_2B_{11}	6575	1424	3,06	2,84
12	A_2B_{12}	6400	1388	3,09	2,77
13	A_2B_{13}	6502	1390	3,05	2,89
14	A_2B_{14}	6280	1368	3,00	2,66
15	A_2B_{15}	6315	1377	3,12	2,98
16	A_2B_{16}	6300	1418	3,54	3,00
17	A_3B_9	6408	1416	3,69	2,95
18	A_3B_{10}	6412	1402	3,96	3,00
19	A_3B_{11}	6370	1398	4,12	3,00
20	A_3B_{12}	6377	1378	4,02	3,17
21	A_3B_{13}	6414	1366	3,98	3,08
22	A_3B_{14}	6300	1388	3,82	2,96
23	A_3B_{15}	6412	1412	3,80	3,25
24	A_3B_{16}	6338	1399	3,98	3,21
25	A_4B_9	6300	1394	3,55	3,04
26	A_4B_{10}	6400	1377	3,76	3,08
27	A_4B_{11}	6315	1368	3,64	2,99
28	A_4B_{12}	6366	1368	3,20	2,96
29	A_4B_{13}	6340	1400	3,00	2,48
30	A_4B_{14}	6425	1400	3,06	2,77
31	A_4B_{15}	4388	1400	3,02	2,86
32	A_4B_{16}	6402	1398	3,46	2,98
33	A_5B_9	6402	1422	3,66	3,00
34	A_5B_{10}	6402	1434	3,98	3,12
35	A_5B_{11}	6556	1436	4,20	3,11
36	A_5B_{12}	6754	1394	3,98	3,08
37	A_5B_{13}	6702	1398	4,00	3,20
38	A_5B_{14}	6512	1358	3,77	2,98
39	A_5B_{15}	6544	1394	3,69	3,18

No	Code-name	Calorific Value (kcal/kg)	CO (ppm)	SO_2 (ppm)	NO_x (ppm)
40	A_5B_{16}	6333	1384	3,99	3,12
41	A_5B_9	6444	1382	3,09	3,28
42	A_5B_{10}	6434	1376	3,04	3,04
43	A_5B_{11}	6554	1384	3,12	2,98
44	A_5B_{12}	6454	1364	3,32	2,78
45	A_5B_{13}	6324	1366	3,20	2,82
46	A_5B_{14}	6712	1402	3,56	2,88
47	A_5B_{15}	6702	1404	3,65	2,89
48	A_5B_{16}	6664	1388	3,90	3,02
49	A_6B_9	6490	1386	3,76	2,98
50	A_6B_{10}	6444	1400	3,37	2,79
51	A_6B_{11}	6354	1428	3,33	2,77
52	A_6B_{12}	6454	1369	3,11	2,75
53	A_6B_{13}	6566	1417	3,24	2,87
54	A_6B_{14}	6702	1425	3,00	2,89
55	A_6B_{15}	6722	1386	3,60	2,99
56	A_6B_{16}	6544	1412	3,99	2,99
57	A_7B_9	6317	1388	6,83	2,88
58	A_7B_{10}	6388	1368	3,60	3,22
59	A_7B_{11}	6428	1354	3,59	2,85
60	A_7B_{12}	6419	1375	3,75	2,80
61	A_7B_{13}	6466	1358	3,65	3,02
62	A_7B_{14}	6556	1400	3,22	3,07
63	A_7B_{15}	6700	1380	3,77	2,78
64	A_7B_{16}	6400	1400	3,97	2,97
65	A_8B_9	6412	1390	3,80	2,98
66	A_8B_{10}	6468	1386	3,09	3,11
67	A_8B_{11}	6500	1355	3,20	3,12
68	A_8B_{12}	6700	1345	3,65	2,78
69	A_8B_{13}	6430	1365	3,96	2,88
70	A_8B_{14}	6245	1399	4,00	2,89
71	A_8B_{15}	6356	1366	4,02	2,66
72	A_8B_{16}	6555	1387	4,20	2,98

Calorific Value.

The results of agglomeration process indicates that the highest calorific value is 6712 kcal/kg. This value is in A_5B_{14}, those are is 50 : 50 blending coal between fraction size 20 mesh, 10% coal - water ratio and 20% oil for semi anthracite and fraction size 30 mesh, 10% coal - water ratio, 20% oil for sub bituminous coal. The lowest value is 6245 kcal/kg, for A_8B_{14}, this blending between 30 mesh fraction size, coal - water ratio 15%, 20% oil and 30 mesh fraction size, 10% coal - water ratio, 20% oil.

The Gas Emission

The minimum CO content is in A_8B_{12}, that is 1345 ppm, and the maximum is 1436 ppm for A_5B_{11}. The maximum SO_2 is 4.24 ppm for A_1B_{12} and the minimum is in A_1B_9, that is 3.00 ppm. The maximum NO_x is 3.28 ppm and the minimum is 2.48 ppm, A_5B_9 and A_4B_{13} respectively.

Conclusion

Based on the result of discussion, the some conclusions can be drawn:

1. Carbonization process effect to increase in fixed carbon content.
2. Agglomeration process effect to decrease in the ash content significantly.
3. The result of blending for calorific value are not optimum.

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