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Briquetting of Washed Coal Fines of Merzifon-Yeni Çeltek Coal Enterprise

G. Özbayoğlu, Ü. Atalay & C. Hiçyılmaz
Mining Engineering Department, Middle East Technical University, 06531 Ankara, Turkey

ABSTRACT: In this study, the influences of some of the most important parameters on the strength of briquettes were studied. The preliminary laboratory studies showed that lime and molasses were the optimum binder combination considering not only the mechanical properties of briquettes but also the operational cost and their availability. Briquetting pressure, amount of milk of lime and molasses, blending time of briquetting charge and drving time were the parameters tested through the research.The best results were obtained with 84.21 kg / cm' briquetting pressure, 5.8% molasses, 5.8% milk of lime, and drying at 50°C for 3 days. The briquettes produced with these values of parameters had more than 67 kg crushing load.The pilot plant scale briquettes production were done at the Mineral Research and Exploration Institute (MTA). A Flowsheet was designed for 10-15 tph capacity briquetting plant.

I INTRODUCTION

Modern coal mining with mine mechanization and advanced coal cleaning techniques generate appreciable amount of fine coal materials that must be processed and handled.

Furthermore, due to the very strict environmental regulations the fine coal production will increase in future, since finer grinding will be required to liberate finely disseminated ash and sulfur impurities from coal. In addition, low quality coals with high moisture content also show a tendency to disintegrate when they are dried. The loading, transportation and unloading processes contribute to the formation of fines. All these fines not only cause serious handling problems such as losses with wind in transportation, spontaneous combustion & freezing but also cause incomplete burning in the furnace. Therefore, the fine coals arc agglomerated to minimize these problems.

Briquetting is the most appreciable and universally accepted method to prevent these serious problems. Briquetting is made practically in every country in which coal is mined. Investigations are being carried out in these countries to check the suitability of domestic coals for briquetting.

The aim of this study is briquetting of -3.36+0.5 mm (-6+28 mesh) washed coal fines of Merzifon-Yeni Çeltek Coal Enterprise. Although the company has no marketing problems with +3.36 mm product, -3.36 mm product can not be sold easily due to its fine size and high sulfur content. The research focused on both to enlarge the size and to reduce the sulfur emission by laboratory and pilot plant test works (Özbayoğlu et. al.. 2002).

2 MATERIALS AND METHODS

Almost 0.5 ton of -3.36 +0.5 mm washed coal sample was used through out the research which was produced by Merzifon-Ycni Çeltek Coal Enterprises. The proximate and particle size analysis of sample are given in Table I and 2 respectively.

Table I. Proximate analysis of -3.36+0.5 mm washed coal fines.

Analysis	Original	Air Dried
Moisture *(7t)*	8.33	-
Inherent Moisture	2.59	2.83
Ash C7r)	25.96	28.32
Volatile Matter *(%)*	.11.91	34.81
Fixed Carbon *CX)*	33.80	36.87
Total Sulfur (%)	2.03	2.21
Combustible Sulfur ('*)	1.74	1.90
Pyrıtıc Sulfur (%)	0 54	0.59
Lower Calorific Value (kcal/kg)	4461	4921
Upper Calorific Value (kcal/kj>)	4714	5142

The laboratory scale briquettes were made in cylindrical shape mould having 55 mm in diameter. They were pressesed with an external pressures varying from 63.15 to 105.26 kg/cm^2. Tinius Olsen Stan-

dard Super L-typc hydraulic press having 200 tons capacity was used throughout the research. The briquettes were dried at 50°C in an oven.

Table 2. Size Analysis of -3.36+0.S mm washed coal fines

Size (mm)	Weight C/r)	Cum. Weisiln <%)	Pyrilie Sulfur C3Î)	Pyrilie Sulfur Dısıılbulum (%)
-U6+1 68	37.40	37.40	0 89	56.60
-1 68+0 595	41.W	78.70	0 49	34.4
-0.595+0 5	21.30	100.00	0.25	9.0
Totril	100.00		0.588	

In pilot-scale briquctting tests. SKB trade name roll press having 630 mm roll diameter & 100 mm roll width was used. The rotational speed of rolls were 2 rpm. The produced briquettes have 45 mm length, 31 mm width and 25 mm thickness.

2. / *Quality Control of Briquettes*

The quality control of briquettes was done by means of compressive strength, tumbling and drop tests. The compressive strength tests were performed by compressing the briquette between two movable plates. The amount of load applied to the briquette, just before the initial crack occurs, was recorded as crushing load (kg) of the briquette. The crushing load in radial direction can be used to express the induced tensile strength of a cylindrical briquette (Ataman, 1982).

$$\sigma = \frac{2P}{DL}$$

where, CT = Tensile Strength (kg/cm")
P = Crushing Load (kg)
D = Diameter of briquette (cm)
L = Length of briquette (cm)

Since "D" and "L" are constant, the crushing load was used to compare the quality of briquettes instead of tensile strength.

It is required to obtain 80 kg crushing load for first class coal briquettes and 60 kg crushing load for 2"'l class coal briquettes (TS I2055. 1996)

Tumbling tests were performed at 20◁▷x30 cm drum containing 4 lifters of 2 cm wide. 500 grams of briquette sample were placed into the drum and rotated two minutes with 30 rpm. The tested material was then screened through 3 mm and percentage of screen oversize material was expressed as Tumbling Index. Tumbling index is 75% for l" class coal briquettes and 65% for 2"J class coal briquettes (TS 12055,1996)

The drop test was carried out to assess the ability of the briquettes to withstand the falls at the transfer points during handling and transportation. The briquettes were allowed to drop from 120 cm height on a concrete platform. The number of drops, before the initiation of any crack was the measure of this test.

The waler resistance test were not necessary since the briquettes will be marketed in nylon bags.

3 RESULTS AND DISCUSSIONS

.?. / *Laboratory Briquetting Tests*

In the laboratory hriquetting tests, the effects of amount of milk of lime & molasses, briquetting pressure, blending time for briquette charge and drying time of briquettes at 50°C were tested.

Preliminary briquetting showed that the coal briquettes produced without binder have not sufficient crushing load. 7.5 to 10 kg crushing loads were obtained from the coal briquettes that made with its original moisture (= 10%) under 126.31 to 168.42 kg/cm" briquetting pressure.

Coal briquettes produced with lime (CaO) have not also sufficient resistance to crushing load. Figure I shows the effect of lime on crushing load of briquettes.

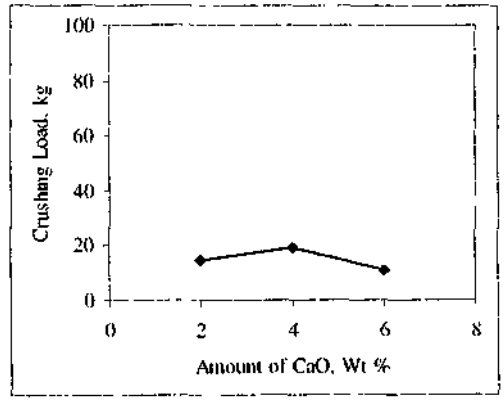

Figure I. The effect of lime on crushing load of briquettes (8/◇ water: 84.21 kg/em" briquetting pressure; drying at 50°C for 2 days).

Preliminary tests showed that briquctting only with its original moisture and lime is not sufficient to produce marketable coal briquettes. Therefore it was decided to use binder at the following tests. Molasses is one of the famous and versatile binder considering its availability, cheapness and effectiveness in binding. So, molasses was selected as the binder for the following tests.

In order to investigate the effect of briquetting pressure to crushing load of briquettes, briquetting pressure was varied from 63.15 kg/cm" to 105.26 kg/cnr with 5.8% milk of lime and 5.8% molasses. The briquettes were dried at 50°C for 3 days. The re-

suits which are shown in Figure 2 indicated that all briquettes have satisfied the crushing load requirement.

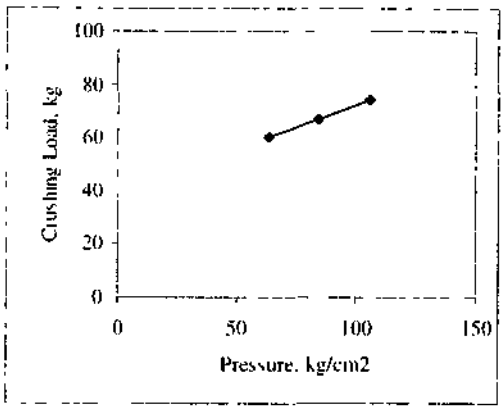

Figure 2 Effect ot briquetting pressuie on crushing load ot bnquettes.

Milk of lime and molasses are an important combination in the briquetting of coal industry. Due to the exothermic reaction between the binding agents, briquettes became hardened without external heating. In this set of experiment, amount of molasses was changed when the milk of lime was 5.8%, briqueuing pressure 84.21 kg/cm" and drying at 50°C for 3 days. The results were given in Figure 3.

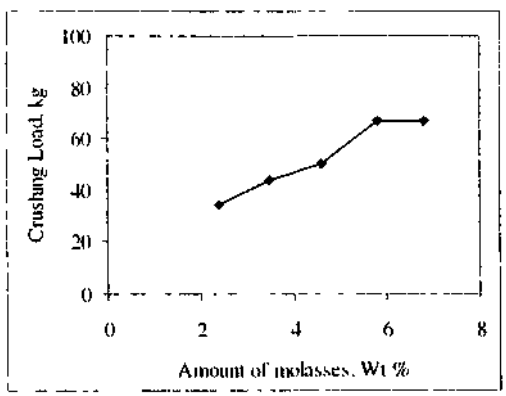

Figure 3 Ettect of amount of molasses on ciushing load ol bnquettes.

As it is seen from Figure 3 amount of molasses has positive elfect on crushing load of briquettes. However high amount of molasses do not only increase the cost of briquettes but also increase moisture which has negative effect on crushing load. So it was determined that 5.8% molasses was the optimum amount.

The effect of milk of lime was investigated herealter. The results of series of experiments can be observed in Figure 4. which shows the positive effect of milk of lime on crushing load of briquettes. High amount of milk of lime will also decrease the SO_2 cmmission to atmosphere by the formation of $CaSO_4$ as the result of reaction of sulfur with lime. However high amount of milk of lime will also increase the content of inorganics in coal briquettes which will be resulted as ash after combustion of it. Therefore 5.8% milk of lime was accepted as optimum value which satisfy the specifications of TS 12055.

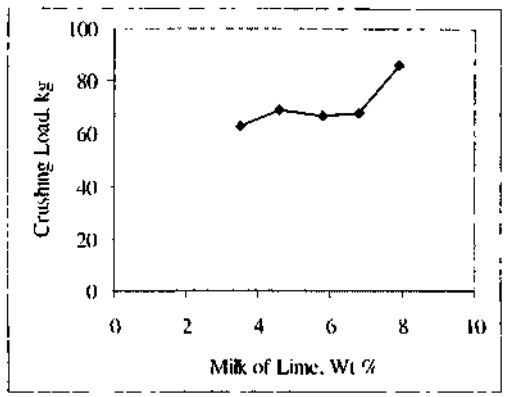

Figure 4. Effect of amount of milk of lime on crushing load ol briquettes (5.8'/ molasses; 84.2lkg/cm2 briquetting pressure; drying at 50"C for 3 days).

Blending tunc is not only important to obtain an homogeneous mixture but also important from the view of reaction kinetics of lime and molasses. It was tested with a set of experiments changing from 3 lo 12 minutes. The results are shown in Figure 5 which can be concluded as "more blending time, more crushing load".

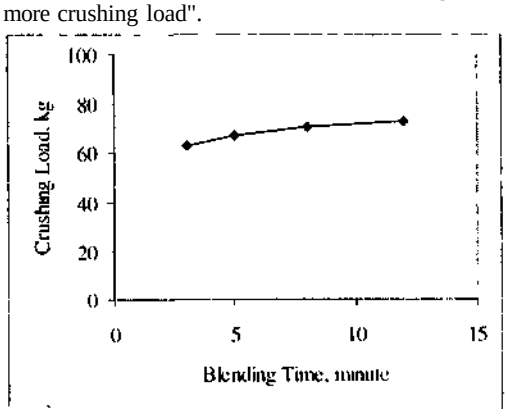

Figure 5 Effect of blending time on crushing load of briquettes (5.8% molasses. 5 8% milk of lime; 84.21 kg/crrr briquetting piessure. drying at 50"C foi 3 days! .

Finally effect of drying time on crushing load of briquettes was tested. The briquettes produced at optimum conditions (5.8% molasses, 5.8% milk of lime.

H4.2I kg/cm" briquetting pressure) were dried at 50°C for different periods. As shown from Figure 6, drying time has positive effect on crushing load of briquettes.

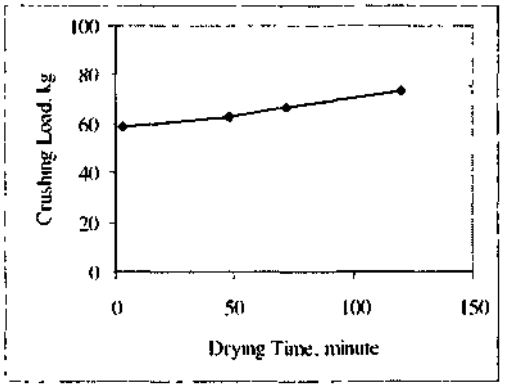

Figure 6. Effect of drying time on crushing load of briquettes

J. 2 Pilot Scale Briquetting Tests

In the pilot-scale operation, coal, milk of lime and molasses were mixed in an automatic cement mixer. The mixture was fed to the roll press where briquettes were produced. Optimum conditions found during laboratory investigations were applied for the preparation of briquette charge (i.e. 5.8% molasses, 5.8% milk of lime and original moisture of coal drying at 50°C for 3 days).

However briquetting pressure could not be adjusted since the roll press used was not operating well. Moreover, feeding mechanism was out of order and moulds on the rolls was not matching each other. Feeding was tried to be done manually.

All these improper conditions prevented the production of briquettes continuously and in desired shape. The average crushing load of briquettes were found as 32 kg. However droping test and tumbling test gave satisfied results where briquettes crushed after 6 drops and pieces of briquettes were all coarser than 3 mm in drop test. Tumbling index was 92[I]/r.

Finally a flowsheet was developed for the briquetting plant with 10-15 tph capacity. Since the moisture of coal was around 10-11 %, thermal drying was not projected in flowsheet. Figure 7 and Table 3 shows the developed flowsheet for Yeniçeltek briquetting plant.

4 CONCLUSIONS

1. Laboratory briquetting tests demonstrated that Merzifon-Yeni Çellek washed coal fines (-3.36+0.5 mm) can be successfully briquetted with binders of milk of lime and molasses. The briquettes are all satisfy the specifications of TS 12055 standards.
2. Milk of lime and molasses amount, briquetting pressure, blending lime and drying time at 50°C have all positive effect on crushing load of briquettes.
3. Although pilot plant briquetting resulted low crushing load due to improper conditions drop and tumbling tests were all satisfactory.

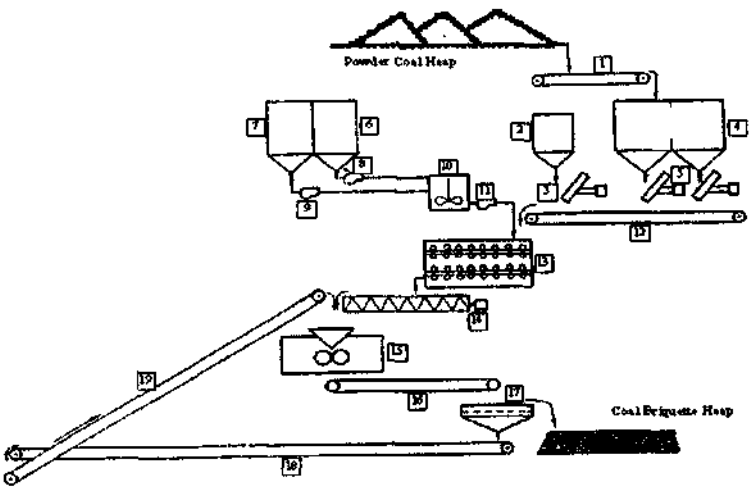

Figure 7. Flowsheet of Yeniçeltek Coal Briquetting Plant (for coal containing 10% moisture).

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Table 3. List of equipment in the plant.

Unit Number	Naine of Equipment
1	Banı Konvevör
2	Lime Bin
.1	Vibrating Feeder
4	Dry Powder Coal Bins
S	Vibrating Feeders
6	Melas Tankı
7	Su Tankı
X	Melas Pompası
9	Water Pump
10	Isıtmalı Karıştırma Tankı
II	Pump
12	Bant Konvevör
13	İki Şaftlı Karıştırıcı
14	Screw Conveyor
1?	Briqueiting Machine (Feeder Included)
16	Bant Konveydr
17	Vibrating Screen
IX	Bant Konvevör
19	Bant Konvevör

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