COLD COAL AGGLOMERATION FOR INCREASING COKE PLANT PRODUCTIVITY *

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Abstract
Currently there is a constant and essential concern of preserving nature. Over the years the concern with the environment is increasing, new environmental laws are emerging and being applied more rigorously and consequently emerge economic needs and mineral processing practices and other materials. In this sense briquetting becomes an alternative to fine particles agglomeration by means of pressure and or temperature, with the aid or not of a binder, which allows to get a product not only compressed, which presents shape, size, and adequate mechanical properties. The reduction in volume of the material in some cases (beyond the technological benefits) also allows fine materials can be transported and stored more economically, safely and effectively. The production of coke is greater as the content of better coking coal is, thus he low capacity coking coal is not much used in coke ovens. This research aims to demonstrate that briquetting of mineral coals with low coking coal capacity is possible, additionally allows increased coke production, obtaining then a better yield of coke. Basically they take advantage of low price of no coking coals without changing the quality of the coke produced. Anyway, briquetting became a smart alternative to aggregate values, economy and care for the environment.
Keywords: Coke, coal, briquetting.

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1 INTRODUCTION

With industrial production on a large scale, the search for new technologies and new ways to reuse waste generated in its processes are being created. The blast furnace is responsible for approximately 95% of the world's hot metal production, with about 40% of the total cost being for coke. A good quality coke is an essential product for the manufacture of hot metal (Casagrande, 2010).

Since 1990, due to the inadequate quality of national coal, the Brazilian steel industry has only used coals purchased in the foreign market in its blends for the manufacture of coke, with which new technologies have begun to be studied and developed, one of them being the study made in this paper. That means by using a mixture of mineral coal with low content of coarse particles, we can obtained similar results of performance of a coal with high level of coking in the coke manufacturing process.

The briquette process is a method consisting of the cold agglomeration of fines. The first patent related to briquetting was granted to William Easby in 1848. The process developed by Easby enabled the formation of solid agglomerates of varying size and shape from fine fractions of any type of mineral coal by means of the pressure exerted on this material. Thus, materials with little or no added value could be transformed into a high value product, fuel for steam engines, forges, cooking and other applications, allowing to recover much of the fines considered as tailings of the coal beneficiation process.

2. Objective

This work aims to solve a problem faced by several coking plants, the residues generated by the transportation of this material, resulting in an accumulation of waste without purpose.

Use of no coking coal jointly with a binding agent to produce briquette to be used in the Coke Plant

3. Literature Review

3.1 Mineral Coal

Mineral coal is of fossil origin, it was one of the first sources of energy used by man on a large scale. Formed through deposits of debris that undergoes some weathering, burying these decaying plants, this process is called carbonization and lasts for about 150 million years. From plants in decomposition to mineral coal there are some formation steps. These steps are lignite, bituminous and sub-bituminous coal (both referred to as coal) and anthracite. Figure 1 shows the evolution of materials to form coal. Table 1 shows the evolution of the materials during time and chemical composition of each material, during this evolution.

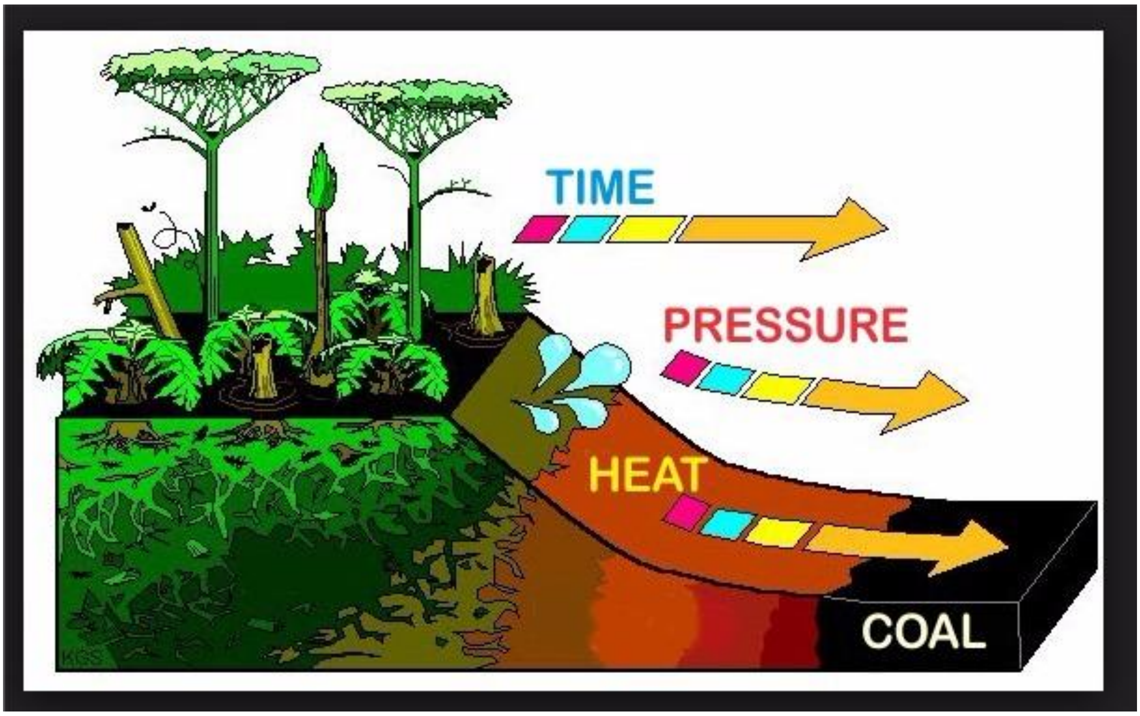

Figure 1 Coal formation process (Nascimento, 2017)

Table 1 Evolution of Carbonification of coal (Casagrande, 2010)

COMPOSITION	WOOD	PEAT	LIGNITE	COAL	ANTHRACITE	GRAPHITE
CARBON	42 - 52	50 - 68	55 - 75	74 - 96	90 - 96	100
OXYGEN	43 - 42	35 - 28	26 - 19	20 - 3	3 - 0	0
HYDROGEN	5 - 6	7 - 5	6 - 9	5 -1	3 -1	0

3.2 Briquetting

In the process of agglomeration of fine particles in presses, the molecular attraction forces of Vander Waals have a strong influence on the union of the particles. However, they only become effective when the distance between the particles is reduced by the action of a high external force.

It consists of an industrial process, which aims at the agglomeration of fine particles in presses that can be of roll (figure 2), briquetting by extrusion and briquetting by a hydraulic press. In the roller press the material flows continuously between two parallel rollers, with cavities or molds arranged on its surface, of adequate size and shape, rigidly connected to one another, rotating with the same rotational speed, sometimes in opposite directions. (Adam, BL; 5th edition)

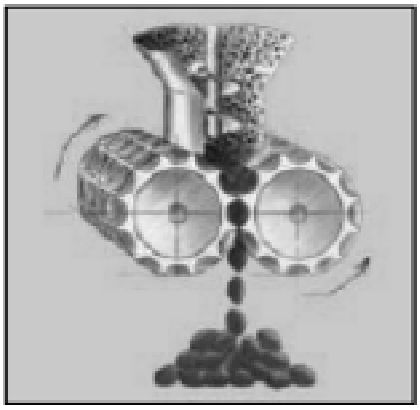

Figure 2 Principle of compression in rolls (Adam, BL; 5th edition)

The production of a briquette as shown in figure 2 is a function of several parameters: the density of the material, the speed of the roll, among others. In equation 1 all the factors that affect the production of a machine are shown:

The briquette flow, M in m^3/s, is calculated as a function of the volume of a briquette (V_b in m^3), the number of molds in a column (Z, m) on the circumference of the roller, the number of columns along the width of the roller (R, m), roller speed (N in rpm) and the briquette density (d_b in kg/m^3).

$$M=V_b \times Z \times R \times N \times d_b \quad (1)$$

(1) Formula to calculate the flow of briquettes (Adam, BL; 5th edition)

4. Materials and Methods

The materials involved in this process are:

- Fine of mineral coal. Coal particles should be between 0.5 mm and 90 µm, with a maximum of 20%> 0,5 mm and a maximum of 5% <90 µm. The ideal moisture content is 2 to 0.5%.
- Tar or other bonding agent, with right viscosity characteristic and composition
- Briquette has as main parameters the following items:

Thermal power, mechanical strength (Shatter and Tumbler Test) and density (pycnometry)

The material was collected at Gerdau Ouro Branco in Minas Gerais, containing about 60 mt. It was transported by trucks to Itaúna, as well as the binder, that was the tar generated in the coking process of that company. Based on previous experiments, the two materials were mixed, and 5% tar was used in each 300 kg blend standard. The production took place continuously.

After the production of the briquettes, some tests were done to guarantee the physical quality of the same, so that he could return the company for tests in the coke oven.

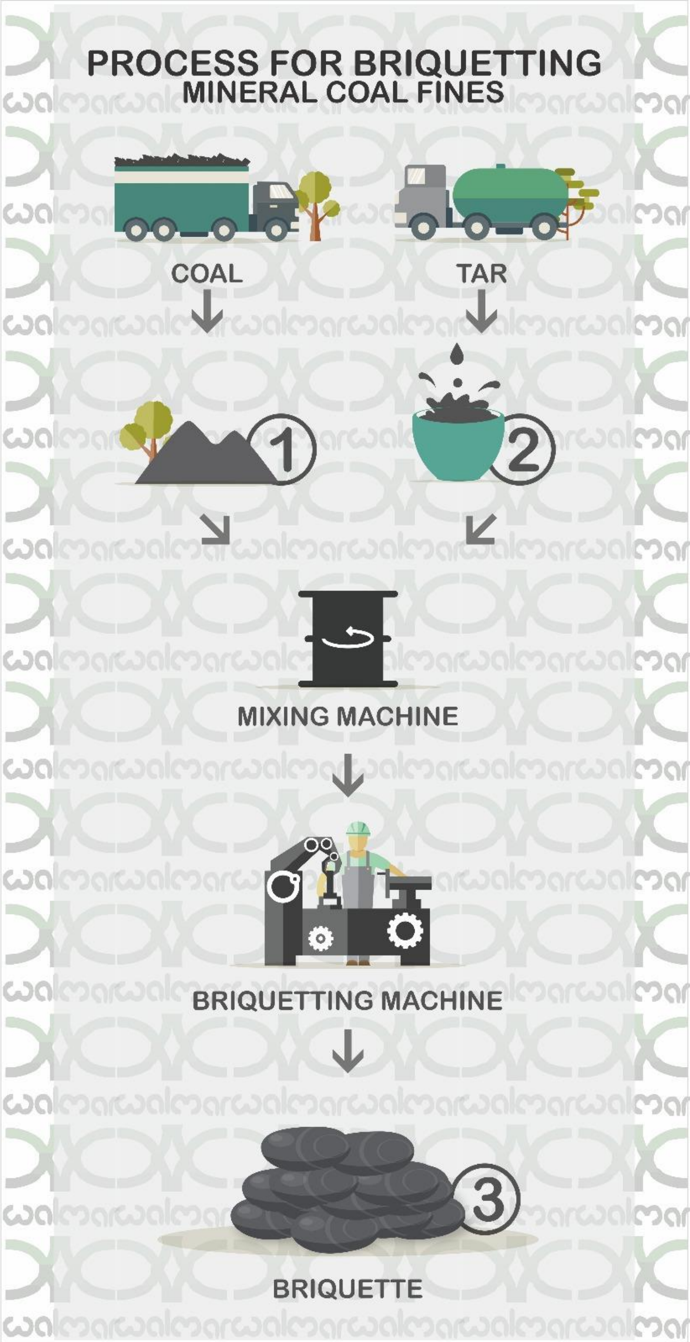

Figure 3 - Material Flow in the company to produce Briquette and Quality Control System adopted.

1 - Coal Quality control

2. Tar Control of Viscosity

3. Strength Briquette Control

The tests performed were done according to bibliographic reference, namely:

4.1 Humidity of Mineral Coal

283,184 g of charcoal sample was weighed, then harvested in a greenhouse for two hours thereafter a mass loss was calculated then the moisture value was determined. Two samples were collected.

4.2 Grain Size Distribution

Seven sieves with openings between 0.5 mm 2,00 mm; 1,18mm; 600 µm; 212 µm; 180 µm; 150 µm and 75 µm were chosen, remaining 10 minutes vibrating at a frequency of 10 Hz. After this procedure the percentages were measured.
In the same way as before, two samples were used to determine the grain size distribution.

4.3 Tar

Tar distillations were done in 1.5-liter glass flasks on a 40 cm-long Liebig condenser, heated with water, and a condenser. Fifteen distillations of the tar were carried out, with 2 hours and 30 minutes each. Purpose of this test is to distill the tar, to see its chemical properties, for its higher yield in the briquetting process as a binding agent.

4.4 Briquette Qualification Tests

Before the heat treatment (curing), the impact resistance of briquettes can be determined by means of free fall tests, from a height of 0.3 m. In this test, a steel plate with a thickness of 10 mm is used as the bulkhead. Impact resistance is determined by the number of consecutive drops that the briquette can resist without fragmenting. For uncured briquettes, 3 falls are considered as a reasonable number, whereas for briquettes subjected to a heat treatment, this number becomes 10.

5. Results

Based on the Methodology shown before, some results can be shown.
Table 2 shows the preliminary results obtained with respect to the moisture of the mixture, as well as data obtained from the briquettes produced

Table 2 - Quality of mineral coal and briquettes

COAL				BRIQUETTES	
MATERIAL	MOISTURE	% > 0,5mm	% < 0,09mm	MECHANICAL RESISTENCE (CONVENTIONAL TEST)	DENSITY (PICNOMETER) kg/m³
01	3,68	16,5	8,8	70%	1,199
02	3,22	23,7	3,3	60%	1,201

As can be seen from the data in table 2 there was a slight difference in moisture between the two mineral coal samples due to the mannose and storage of the material, despite the variation in the coal granulometry, it fit the desired parameters in that test. The results on resistance of the two briquette samples were satisfactory and the density calculated on the picnometer also fitted the literature and the expected results.

The data related to the tar experiment were not yet separated

6. Conclusions

The raw material used were coal moisture humidity between 3,68 and 3,22%.

The grain size of the mineral coal did not meet the literature specifications. A percentage greater than 20,1%> 0.5mm and 6,05 <0.09mm was observed.

The mechanical strength of the material met the basic quality requirements in all tested briquettes.

The density of the briquettes also met intrinsically and in bulk: the values were of the order of 1,199 and 1,201 kg / m^3.

7. Literature

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