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POTENCIAL UTILIZATION OF THE HUSK FROM MORINGA OLEIFERA SEED IN BLAST FURNACE INJECTION

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ABSTRACT Moringa oleifera is known as the tree of life for its numerous applications in the pharmaceutical, cosmetic and nutritional industries. The husk has some chemistry properties that are interesting to use in the energy generation. However, coal is the most used material for blast furnace injection, which is a non-renewable fossil fuel and emits a huge amount of greenhouse gases. The use of the husk from Moringa oleifera seeds have positive environmental and economic effects as renewable sources of fuel. This study aims at characterizing the husk from Moringa oleifera seed and evaluating its use as a pulverized material injection for the blast furnace. Initial results show that this material has a good combustion rate, high volatiles and hydrogen content. Despite the carbon content and calorific value been lower than coal, it is possible to use 40% of the husks in the injection with the coal mixture, reducing 30% of CO2 emissions in the injection process.

KEYWORDS : Moringa oleifera, blast furnace injection, ironmaking, biomass

INTRODUCTION

Moringa oleifera is a versatile tree, which adapts well to soils with low humidity and hot climates, with numerous uses in the pharmaceutical, cosmetics, food and others. Its oil has great potential for not only the production of cosmetics and medicines, but also for the production of biodiesel [1].

An unexplored use is to generate energy and in the case of this research, for the production of hot metal in steel mills. When extracting the oil, some wastes was generated such as the seed bark and the waste after the mechanical pressing or solvent extraction of the peeled seeds. These wastes have great potential to generate energy for processes such as the injection of pulverized materials in blast furnaces [2].

The blast furnace pulverized materials injection process is a technique that has been consolidated in steel mills in the middle of the last century and is now known worldwide, being applied in more than 400 blast furnaces around the world. In this process the fuel is injected into the blast furnace by the blast furnace, which is located in the lower part of the reactor, providing energy and reducing gases for the process of obtaining hot metal which is the basic raw material for the production of steel. The main advantage of this process is reduce the solid fuel charged in the top of the furnace as coke and charcoal [3]. The most commonly used fuel in the injection process is coal, which is known as a non-renewable fossil fuel. In addition, it is responsible for almost all CO_2 emitted in the atmosphere and it is a fuel restricted to some countries as Brazil [4].

This work aims to characterize the *Moringa oleifera* seed bark, which is a waste from the seed oil extraction process, to be used as fuel with coal in blast furnaces. Chemical and thermal analysis of the moringa seed husk will be shown, which are compared with the properties of coals commonly used in the injection process. Finally, a small analysis of the CO_2 emissions will be shown. It will be notice that is possible to replace 40% of the coal by moringa seed husk in the process, reducing the emissions of greenhouse gases in 30% only in the process of pulverized materials injection.

MATERIALS AND METHODS

The materials used in this research were the *Moringa oleifera* seed husk and coal commonly used in blast furnace injection. Proximate analysis to determine the amount of ash, volatile materials, moisture and, by difference, the fixed carbon were performed in the Analytical Chemistry Laboratory of the Chemistry Department in Federal University of Ouro Preto, according to ASTM D3172 through D3175 for coal and ASTM D1102, E870 to E872 for biomass.

Ultimate chemical analysis was done in INPE (National Institute for Space research) using a Perkin Elmer equipment that provided the contents of carbon, hydrogen, nitrogen, sulfur and, by difference, the content of oxygen. Calorific value was also performed at INPE using an IKA C200 adiabatic calorimeter, in this test it was possible to obtain higher calorific value.

The combustion test for determination of combustion rate was performed in the Pulverized Materials Injection Simulator Laboratory of Federal University of Ouro Preto (Figure 1). The test was done with the pure materials and also with mixture of both materials.

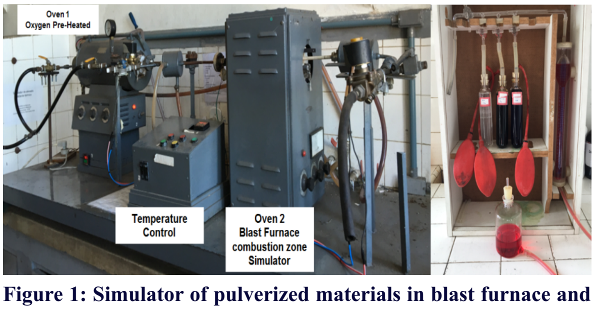

Figure 1: Simulator of pulverized materials in blast furnace and ORSAT for gas analyze.

The test starts in the injection simulator equipment, where it is possible to simulate the same conditions of the combustion zone in blast furnace. Then the gases are collected and analyzed in the ORSAT equipment, where by chemistry reaction it is possible to determine the amount of CO, CO2 and O2 for calculation of the combustion rate, according to the following equation [5]:

$$CR = \frac{K.(\%CO + \%CO_2).n}{[\frac{ma.\%Cf}{1200000} - \frac{ng.\%CH_4}{100}]}$$

where:

CR is the combustion rate; K is a constant relative to the simulation parameters and conditions; ma is the mass of carbon injected in the sample; ng is the number of mols of gas after the test; % Cf is the percentage of fixed carbon of the sample.

The proximate and ultimate chemical analysis, as well as the calorific power were performed in triplicate. The combustion test was done in duplicate, simulating injection rates of 80, 100 and 150 kg of material injected per ton of hot metal produced by the blast furnace.

For calculation the CO_2 emissions, the following equation was used [6]:

ECO_2 = (Carbon content (kg) x 44)/12.

RESULTS AND DISCUSSION

After analysis the results were noted and shown below.

Table 1 shows the results of the proximate, ultimate and calorific value analysis for the *Moringa oleifera* seed husk and for the coal.

TABLE – 1 PROPERTIES OF MORINGA SEED HUSK AND COAL

Properties	Moringa Seed Husk (MH)	Coal
% Ash	2,36	13,45
%Volatiles	76,60	24,13
% Fixed Carbon	21,04	62,41
%Carbon	48,84	80,24
%Hydrogen	6,27	3,8
%Nitrogen	0,93	1,54
%Oxygen	43,96	14,42
%Sulfur	0,83	0,88
Calorific Value (J/g)	20337,00	31396,00

It is possible to notice that the husk of moringa seed has lower content of ashes, carbon, fixed carbon, nitrogen and sulfur. In contrast, the content of volatiles, hydrogen and oxygen are higher. The calorific power of coal is also greater than moringa seed husk.

One important fact is the large amount of volatile material in the husk, more than double that of the carbon content. Materials with high volatile content present greater combustibility [7]. This type of material is desired for high injection rates, due to the short residence time of this material in the blast furnace combustion zone. However, a high content of volatiles increases the volume of gases generated, increasing the instability of charge and degradation of the coke. Another problem is that these large amounts of gases increase the pressure in the region of the tuyers. In addition, high volatile content means a higher content of hydrogen in its composition, which contributes to the reduction of iron ore. The presence of larger amounts of hydrogen may be beneficial to the process since it can act as a heat generator. Hydrogen reduces iron ore in a less endothermic way, it means, requires less energy to occur the reduction reaction. With this, it is possible to operate the blast furnace with a lower flame temperature than when using materials with lower hydrogen contents. In contrast, hydrogen causes a premature degradation of the coke in the blast furnace, damaging the permeability through the formation of fines inside the reactor.

Another important fact is the content of ash and sulfur. The amount of ash must be less than 10% for not increase the amount of slag and consequent loss of productivity. Sulfur contributes in the same way and also contributes to the change of basicity of the slag. In addition, high sulfur contents require greater expense with subsequent desulphurization processes, since sulfur is extremely detrimental to the mechanical properties of the steel.

Figure 2 shows the results obtained in the injection simulation test for the injection rates of 80,100, and 150 kg of material per ton of hot metal.

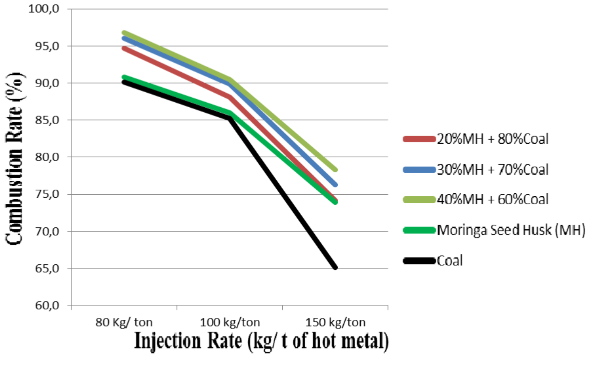

Figure 2: Combustion rate of moringa seed husk, coal and mixtures in different injection rates. A legenda está difícil de ler e os eixos estão desfocados

As the moringa husk has better combustibility, due to its properties, the increase of the amount in the coal influences positively the combustion in the raceway. This is an important fact to consider the use of the *Moringa oleifera* seed husk as an additive to the mixture of coals used in the injection, increasing the combustion rate of the material to be injected.

In the same way it can be said that the use of the pure husk in the injection is not interesting as the use of the mixture. It is clear that the presence of the mineral coal in the mixture positively helps the combustion rate. This can be explained by the O / C ratio in the combustion zone, since the husk contains a considerable amount of oxygen and the coal has high carbon content, which favor this ratio and consequently the combustibility of this mixture [8].

Environmentally the partial use of the moringa seed bark can contribute significantly to the reduction of CO_2 emissions in the blast furnace, which accounts for 70% of all emissions of this gas in a steel mill [9].

Considering that all CO_2 released in the husk burns is consumed during the growth of *Moringa oleifera* by photosynthesis process. That a company that produces 10 thousand tons of hot metal a day injects 150 kg of coal per ton of hot metal. At the end of the day it can be said that 4400 tons of CO_2 are emitted in the process of pulverized materials injection. Substituting 40% of this coal for moringa seed husk the daily CO_2 emission would be 1320 tons. This result represents a 30% decrease in CO_2 emissions in the blast furnace injection process.

CONCLUSIONS

The main conclusions obtained in this study were:

The *Moringa oleifera* seed husk has a lower carbon, nitrogen, sulfur, ash and fixed carbon content than the coals commonly used in the blast furnace injection process;

The calorific power of the *Moringa oleifera* seed husk is also lower than coal;

The contents of volatile materials, hydrogen and oxygen are higher than coal;

The moringa seed husk combustion rate is better than that of coal, but mixtures containing 40% of bark and 60% of coal showed better performance due to better O / C ratio;

The moringa seed bark can partially replace coal in the injection of pulverized materials in the blast furnace reducing CO_2 emissions by 30% in this process.

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