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Production of fuel briquettes from esparto partially pyrolyzed

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Abstract

The aim of this study is to prepare a solid fuel from the most abundant biomass of Morocco that can be used by the local population, and in particular by the rural ones, instead of the wood of forest, which is less available and its exploitation is negative for the environment. Esparto is the most available biomass, with a production of 560 000 tons annually of dry matter approximately. However, briquettes of esparto have low calorific power and their mechanical properties are bad. To improve the quality of the briquettes and to have an economically competitive product at the same time, the esparto was partially pyrolyzed at temperatures between 160 °C and 400 °C, and the pressure of densification has been examined. The combustion profile of the samples has been studied by applying the derivative thermogravimetry technique, and the mechanical properties of the briquettes were tested to evaluate the impact resistance and water resistance. This study showed that strong briquettes can be obtained with a higher calorific value when the esparto is partially pyrolyzed, and a relatively elevated densification pressure is applied.

Keywords: Esparto; Briquettes; Partial pyrolysis; Thermogravimetry

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1. Introduction

In the last two decades, biomass has acquired considerable importance for a variety of energy and other uses: as bio fuels for domestic cooking, industrial process heating, electrical power generation etc. The advantage of these alternative energy sources is that they are renewable and have low cost production. Therefore, it is an opportunity for developing countries that, for them, have considerable energy deficit and their biomass resources are very abundant.

The processes used to convert the biomass to an appropriate form to take advantage of its energy content are pyrolysis, gasification or densification. The last one, known as briquetting technology, appears to be an attractive solution for biomass material. The resulting product is a briquette that has a greater volumetric energy density and is easy for storage and transportation.

Some studies have reported the use of biomass in the production of briquettes from tea waste [1], straws of colza [2], wheat straw and waste paper [3], olive refuse [4], cotton stalks [5], or as a binder for lignite [6–8]. Each country evaluates its own biomass resources. The kinds and amounts of biomass show important differences for different geographical areas depending on its climate, flora and agriculture.

In Morocco, one of the most abundant biomasses is esparto with immense land coverage estimated at 3.6 Mha, more than half the forest surface of the country with the biggest part situated in the oriental region with 2.3 Mha [9].

Esparto is a vivacious plant, very resistant to dryness, constituted of two parts: an underground part called rhizome that is very important for its regeneration, and the aerial part reaching about one meter of height constituted by branches carrying the leaves called tuft.

Forty years ago, the esparto was very well exploited; a good part being exported to Europe where it was used extensively in the paper industry. Locally, it is used in the production of livestock food and as a fuel without any revalorization in the factories of sugar and cement and by the rural population for cooking and heating. These applications created work for local people during 7 months of the year.

Since 20 years, the esparto is completely underexploited for lack of an application; the export has ceased; and the national factories don't use esparto anymore. Only the domestic use remained. This situation generated an excess of laborers in the zone and contributed to urban migration.

All surfaces of the growth of esparto are, in general, very productive. According to some studies, the production of this biomass is 400 to 1800 kg/ha/year depending on the region. Therefore, a surface of 1.5 Mha, identified as ecologically exploitable without risk of deterioration and impoverishment, gives a production of 560 000 T dry biomass per year [10,11]. This quantity of unutilized matter could be evaluated for energy use.

In the present work, the combustion characteristics of esparto and partially pyrolyzed esparto were examined, and the mechanical properties of the briquettes were investigated with respect to the temperature of pyrolysis and the pressure of densification.

2. Experimental

The esparto plant has been obtained from the oriental region of Morocco. The power calorific value (PCV) was measured by a Parr bomb calorimeter in a dry basis using samples of 1 g accord-