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[1.]Gürdil Alp Kağan GÜRKAN, [2.]Bahadir DEMIREL, [3.]Kemal Çağatay SELVI,
[4.]Önder KABAŞ, [5.]Valentin VLĂDUT

EVALUATION OF WASTE BIOMASS FROM OAT CULTIVATION FOR ENERGY

[1-3.]Department of Agricultural Machinery and Technologies Engineering, Agricultural Faculty, Ondokuz Mayıs University, Samsun, TURKEY
[4.]Department Vocational School of Technical Science, Department of Machinery and Metal Technology, Akdeniz University, Antalya, TURKEY
[5.]INMA Bucharest, ROMANIA

Abstract: Energy demand of the world is increasing day by day as the population increases. Plant origin agri-wastes have an important energy potential, and are environmental friendly with low emission values. Solid biofuels from agri-wastes in the form of briquettes can be a good alternative renewable energy resource to fossil fuels. In this study, biomass waste from oat cultivation were dried till 10-14 % moisture content and chopped till 10 mm particle size and converted to briquettes by a hydraulic press under 240 MPa pressure. Some parameters for briquettes like density, breaking resistance[shatter index), shaking resistance[tumbler index), moisture resistance of briquettes, water intake resistance, ash content, calorific values and chimney gas emission values were determined.
Keywords: biomass, agricultural residue, energy, oat

INTRODUCTION

Biomass is the name to given all Earth's living matter. Biomass is general term for material derived from growing plants or from animal manure which is effectively a processed form of plant material such as wood from natural forests, waste from agricultural and forestry processes, and industrial, human or animal wastes. The stored energy in the plants and animals, or the waste that they produce is called biomass energy [14]. Energy production from biomass is becoming very important since there's a huge potential on the world, especially from agricultural production. Biomass energy potential of Turkey is estimated as 32 Mtoe[4], [17] and the total recoverable potential was estimated to be about 16.9 Mtoe[4], [15].

Side products from agricultural production are a very good source of alternative energy. Some of these side products such as residues or wastes from a particular crop can be converted to biofuels but, the productivity of agricultural resources used for production of biomass for energy purposes depends on the further development of biomass conversion technologies. Besides, the use of biomass resources which are defined as "CO2 neutral" [6] in the energy sector is important for Turkey to fulfil the possible future commitments based on the Kyoto Protocol.

Moreover, the use of indigenous resources such as coal and bio wastes for energy production is of critical importance in reducing energy imports. Among the combustion technologies, fluidized-bed technology has become more important because of its ability to burn different types of fuels due to the good mixing in the combustor and the high combustion efficiency achieved with less air given into the combustor [5], [16]. So, the potential to build power plants using coal as main fuel and various biomasses as supplementary fuel appear to be a promising choice for Turkey. Thus, the disposal of biowastes will be achieved and the energy content of the biowastes will be used beneficially in the country's energy production.

Briquetting is the process of conversion of agricultural waste into uniformly shaped briquettes that are easy to use, transport and store. The briquetting of biomass improves its handling characteristics, increase the volumetric calorific value, reduces transportation costs and makes it available for a variety of application.

The aim of this study is to investigate utilization possibilities of biomass residue from oat cultivation for energy in the form of solid biofuel. Some parameters of oat residues briquettes such as; density, breaking resistance [shatter index), shaking resistance [tumbler index), moisture resistance of briquettes, water intake resistance, ash content, calorific values and chimney gas emission values of oat straw briquettes were determined.

MATERIAL AND METHOD

This study was conducted in laboratory of OndokuzMayıs University Agriculture Faculty, Agriculture Machinery and Technologies Engineering Department in Samsun, Turkey. Cultivation residues of oat biomass were used as material. The material was dried in natural conditions until the moisture contents of 10-14%.

Material was primarily chopped and grinded by a hammer mill to 10 mm particle sizes. Then the dried and milled materials were briquetted by a hydraulic type press under 240 MPa pressure without using any adhesive. Heating values of the samples were determined according to European Committee for Standardization [13]. Before testing, the moisture contents of the milled samples were determined according to [10], and [11].

Before briquetting, material was filled in a certain capacity container from a certain height [about 4 cm) to determine the density of the material and the filled material was recorded by weighing. The material density was calculated by dividing the material weight by the volume of the container. Hectoliter and precision scales were for measuring briquette's volume weight. To determine briquette density, water flooding method was applied. Briquettes were covered with stretch film to prevent water absorption [Figure 1). The mass of covered briquettes were recorded. By dipping the covered briquettes into water container, volumes of briquettes were calculated.

Figure 1 - Briquettes from oat biomass

For shatter resistance, briquettes weights were recorded before testing than the briquettes were dropped from a certain height [1-1.8 m) to hard ground for 10 times and the weights were recorded again. The shatter resistance was calculated as a percent [Figure 2).

Figure 2 - Shatter test

For determining Tumbler resistance 5 briquettes were weighed before settled test apparatus according to in ASAE S269.4 standards [3]. Then briquettes were placed test apparatus and rotated 40 min^{-1} for 3 minutes. At the end of rotation, briquettes were weighed again. Tumbler resistance was calculated as a percentage depending on the weight loss that occurs during the test.

Water intake resistance is a measure of the percentage of absorbed water by briquette immersed water. In this test each briquette weight before immersion in water was weighted and recorded. Then, each briquette was weighted and recorded again about 11°C by immersion in normal tap water, with 30 second intervals for a total period of two minutes. Water intake resistance, depending on the increase in weight was calculated as a percentage.

The ash content was determined according to EN14775 standard [12] results are given in Table 1. Emission measurement contains measurements of exhaust gases discharged into the atmosphere as a result of various activities. Briquettes was measured

with flue gas temperature flue gas analyser to determine flue gas emission values burned in conventional type stove used in household heating and flue gas emission values [O_2, CO, CO_2, SO_2, NO_x) coming out as a result of burning [Figure 3).

Figure 3 - Gas emission measurement test

At the beginning of combustion carbon monoxide [CO) and carbon dioxide [CO_2) emissions were increased rapidly because of the decrease in oxygen content [O_2). Then CO and CO_2 emissions began to decline with the increaseof O_2 content in the combustion chamber as a result of steady-state the combustion process.Similar results were achieved withthe research of [8], [7], [1].

RESULTS and DISCUSSION

At the end of the study, briquettes having lengths from 75 to 95 mm long and 50 mm diameter without central hole were produced. It's observed that well shaped briquettes were produced under high pressure values by hydraulic type briquetting machine.

Selected particle size and moisture content of material were suitable for briquetting. Average density of obtained briquettes were suitable as a briquette [higher than 1000 kg/m^3 which given in literature). This was proved by the results of Shatter and Tumbler tests.

Water intake resistance of briquettes was not so good, because they started to dissolve in the water at the second attempt.

Ash content of the oat biomass briquettes was good enough for a solid biofuel according to [12] EU Standard. Heating value of briquettes were higher than normal wood and gas emission values were below the allowed limits given in Heating Air Pollution Control Regulations.

Some parameters of oat biomass in the form of briquettes were given in Table 1.

Table 1. Some parameters of oat biomass

Specification	Unit	Value
Density of material	[kg/m3)	45.55
Density of briquettes	[kg/m3)	1044.37
Ash content	[%)	9.32
Heating value	[cal/g)	4250
CO	[ppm)	1982
NOx	[ppm)	136.33
SO2	[ppm)	0
CO2	[%)	4.65
O2	[%)	7.6
Tumbler index	[%)	17.91
Shatter index	[%)	4.72
Water intake resistance	[%)	Dissolved

CONCLUSIONS

The results showed that, heating values and ash contentsof briquettes were appropriate to be used as a solid biofuel according to [9]. This means that oat biomass obtained after harvesting can be effectively used as an alternative energy source in combustionsystems. Briquettes of oat biomassafter burning in a traditional stove remainedbelowthe specifiedlimit valuesdetermined by Heating Air PollutionControl Regulation [2]. It is seen that oat biomass is very suitable for briquetting without the use ofany adhesive materialwith a hydraulic type briquetting machine.

This study supported that converting agricultural residues/wastes to solid biofuels is an effective way of creating environmental friendly alternative energy sources. The last but not least, the number of such researches must be increased to stress on this energy potential.

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