



"HENRI COANDA"  
STEFANIK  
AIR FORCE ACADEMY  
ROMANIA



"GENERAL M.R."  
ARMED FORCES ACADEMY  
SLOVAK REPUBLIC

INTERNATIONAL CONFERENCE of SCIENTIFIC PAPER  
AFASES 2012  
Brasov, 24-26 May 2012

## DURABILITY OF WOODEN BRIQUETTES

**Aurel LUNGULEASA\***

\*Faculty of Wood Engineering, Transilvania University, Braşov, România

**Abstract:** *The paper presents some aspects about durability of wooden briquettes. This can be considered as a new method for briquettes characterization. This feature of briquettes characterizes the compactness and quality of briquettes, nearby of density and compression. Inside of paper there will be presented other type of durability for composites and even pellets and their methodologies. In the case of wooden briquettes the paper proposes itself to present the methodology, experiments, analyses of results and conclusions related to durability. It is analyzed two types of wooden briquettes and put in balance five factors of influences. Final conclusions of paper show that the negative aggregation of all influencing five factors of durability on the same type of wooden briquettes will lead to drastic decrease of properties or even completely destruction of briquettes.*

**Keywords:** *wooden briquette, durability, renewable fuel, vibration apparatus*

### 1. INTRODUCTION

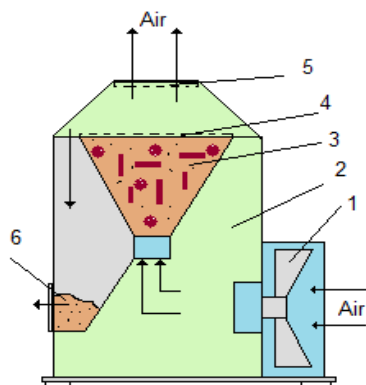
Mechanical durability is the property of woody materials to be resistant to the destruction or removal of a surface layer with some strong abradable bodies. This property is especially needed when using wooden materials for boards, floors, stairs, door frames and even some pieces of machinery with high wear degree. Procedures for determining the durability of lignocellulosic materials are various, among which it can mention: sand blasting, by grinding up imitating human steps, impact with an alternative sanding, ball rotation on surfaces etc. The degree of durability of the wood materials are generally expressed by loss of mass.

To determine the durability (or wear, or abrasion) of wooden composite plates it can be used some prismatic specimens having a square base of 50mm and a height equal to that of the base plate [2, 3]. These pieces are glued on a wooden support. Equipment is composed

of a trolley for horizontal movement of the specimen in both directions and an abrasive device placed above the specimen with a vertical displacement, such as to imitate human leg movement, in it's the natural wood wear. Because the value of the mass loss for plates is very small, in this case the durability is expressed per unit area of the specimen (50×50 mm) and not per its total mass (almost neglectable).

Most of durability testers are made for pellets and less for briquettes. There are a lots of testing devices to characterise pellet stability during handling. Pellet Durability Test is done with special apparatus tests offered by UK Company Borregaard Ligno Tech [1]. This apparatus determines whether the pellets have good physical properties, high quality and consistency. Lignotester's LT-III is a portable pneumatic tester ideal for use in any location of quality control pellets and its operating principle is presented in figure 1.

LT III Lignotester tester simulates the environment in which the pellets are stored and are transferred from the factory to the customers.



**Fig. 1.** Lignotester LT III for determining the pellets durability: 1-axial fan; 2-pressure chamber; 3- room for shaking pellets in ascendent air flow; 4- sieve; 5- mesh filter; 6- door to remove dust

The pellets are pneumatically tested in cascade airflow inside of a pressure chamber 2. As the pellets collide with each other and from the hard surface and perforated drain basket, they will wear. Dust is produced due to the physical process and passes continuously through the perforated sieve 4 of the test room during testing. LT III is a semi-automatic tester. Sample is 100 grams of pellets, weighed with a balance to the nearest 0.1g, placed in the test chamber 2. Tester is switched on, operates 30 seconds and then stops automatically. Test chamber 2 is swung to store the pellets in a container on a balance. Weight balance is displayed on the index value of the pellets durability. This tester is ideal for controlling the manufacturing process of pellets.

The main objective of this paper is to establish a methodology for determining the durability of wood briquettes, given by the situation that no such determination method exist in this domain (compared with pellets), but mainly because wooden briquettes can still deliver in bulk, packaged in polyethylene film for protection. During transport, unpacking, storage and use of the recipient, briquettes will rub against each other and installations walls, producing the certain loss. The determination

of these losses is the objective of laboratory initiated methodology.

## 2. EXPERIMENTAL

Experiments on the determination of briquettes durability were made in laboratory conditions, using two types of briquettes. First of briquettes are obtained on a hydraulic machine from wooden chips and the second ones are obtained on a mechanical press from sawdust obtained from a circular saw. All characteristics of the two types of briquettes are presented in Table 1.

**Table 1.** Characteristics of used briquettes

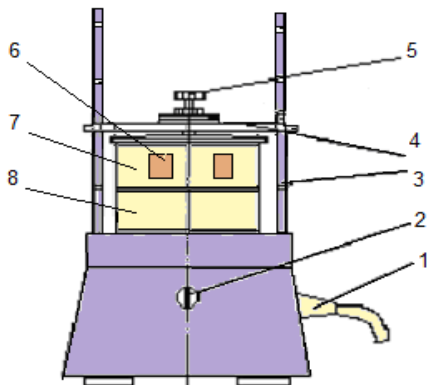
Characteristics	Briquettes type	
	Type 1	Type 2
Press type	Hydraulic	Mechanic
Raw material	Chips (beech and spruce)	Sawdust (beech and spruce)
Visible aspects	No gloss, no cracks	No gloss, with many cracks
Moisture, %	10 ± 2	10 ± 2
Diameter, mm	40	66
Density, kg/m <sup>3</sup>	780 ± 30	760 ± 20
Compressive strength, N/mm <sup>2</sup>	2.0 ± 0.2	1.2 ± 0.1

Wooden briquettes and the waste material resulted after durability are collected. For experiments it has used a mechanical vibration device for sorting, whose operating principle is shown in Figure 2. As methodology, it has been used 3 wooden briquettes, which were subjected to vibration inside of box for a period of 5 minutes, above of sieve of 3 mm. Firstly three briquettes are weighed on a balance with electronic scales in grams, with an accuracy of two decimal, then they are placed over the sieve of the vibration device, then put the lid and tighten the nut. The installation starts and lasts 5 minutes. During this period briquettes are agitated over the grid, and the friction that occurs between them and the sieve and the side walls of the sieve



INTERNATIONAL CONFERENCE of SCIENTIFIC PAPER  
AFASES 2012  
Brasov, 24-26 May 2012

will obtain a certain amount of dust. After shut-down the device with the button 2, it weighs the amount of dust obtained and reported to the original mass of briquette.



**Fig. 2.** Vibration apparatus for determining durability of wooden briquettes: 1- power cable, 2- start and variation button of vibration amplitude, 3- columns; 4- device for lid tight, 5- knob with nut tightening; 6- briquettes; 7- sorting box with a sieve dimensions of  $3 \times 3$  mm, 8- pack of the dust collecting

In this way, the degree of durability for wooden briquettes are obtained, a performance indicator for quality of briquettes. To determine this indicator the following relationship is used:

$$A = \frac{m_l}{m_i} \cdot 100 \quad [\%] \quad (1)$$

A - abrasion, expressed in %;  
 $m_l$  - mass of briquettes loss, in g;  
 $m_i$  - initial mass of briquettes, in g.

### 3. FIVE CRITERIA OF ANALYSIS

Durability of wooden briquettes, usually expressed as the degree of durability, has a great number of influence factors [2], but mainly correlated with their density and compression [5]. Thus, if the wooden briquettes have high density and compression

the durability will be surely lower. In a general way it can say that as the briquettes has a little durability the better quality of briquettes will be, that means it will lose less of them during transport and storage [5]. To this general rule it can add the fact that if the briquettes have some cracks, then they will have a higher durability. The high variation of air humidity will create cracks and decay of briquettes, meaning a large detachment of amount of dust and even pieces of briquettes. Worst wooden briquettes are those to which a large dust and pieces amount are lost [4].

Also, if the wooden briquettes have a natural gloss, they will have a higher compaction and less durability. Luster is given to wooden briquettes by the increased compaction of cylindrical outer surface, but can be also increased by heating and charring of even outside surface. Therefore, it is very important that the briquettes compactness and its outer gloss to be very high for obtaining a good low durability.

If it is analyzed the two types of wooden briquettes we observed that the general principles set forth in above paragraphs shall meet. A first idea on the two types of briquettes assessed on the principle of operation of the plant for briquetting, namely the mechanical installations have raised the possibility of compaction of briquettes to  $1200 \text{ kg/m}^3$ , which has not happened in our case, because the briquettes only had a density of  $760 \text{ kg/m}^3$ , even lower than those obtained by hydraulic press ( $780 \text{ kg/m}^3$ ). From this point of view since the beginning we expect that such wooden briquettes to have a lower durability.

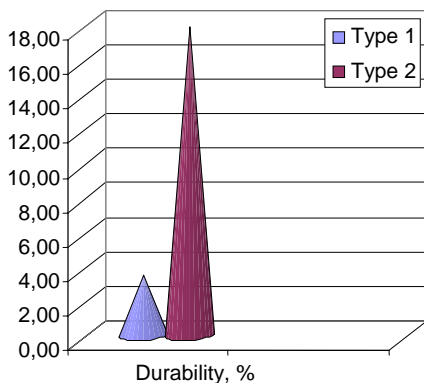
A second element of comparison is that of appearance, namely if they have or no cracks. Both types of wooden briquettes do not have bright, so it can not differentiate in this regard,

but the second ones have a lots of cracks on the outer surface, which is why it expects them to have a high wear.

A third element of wooden briquettes comparison is the raw material used to make them. Both types of wooden briquettes are made of beech combined with spruce, in 1/1 ratio, but type 2 is made of sawdust compared with the first type that is realized from wooden chips, it is expecting them to be more compact, but this does not happen. For these reasons, type 2 of briquettes will have a weaker durability than the first ones.

A fourth element of comparison and one of the most important is the density. From this viewpoint the wooden briquettes type 2 has a lower density, namely  $760\text{kg/m}^3$ , against the other type 1 of briquette that is  $780\text{ kg/m}^3$ . Therefore the briquettes type 1 will have higher wear than type 2.

A fifth element of comparison and distinction of the two types of wooden briquettes and the overwhelming influence is the compressive strength of briquettes. From this point of view it can see a clear difference in favor of a briquette type 1, which have a resistance of 2 MPa, compared to type 2, which has only 1.2 MPa, namely with 66% higher.



**Fig. 3.** Durability value size of two types of wooden briquettes

This difference translates into a better durability of type 1 of wooden briquettes.

Summarizing all five previous distinctive features of comparing (procedures of briquetting, raw material, cracks, density an

compression strength) it can see that all the influence factors favors the type 1 of wooden briquettes, which is why this type of durability of 3.5% is much better than type 2 of briquettes, namely 17.9 %, that means a increasing durability of type 2 of 5.1 times (see fig. 3).

#### 4. FINAL CONCLUSIONS

Durability is an important feature of pellets and briquettes, which characterize the stability and compactness, along with other features such as effective density, compression and shear [5]. There are many determinations of pellets durability and no for wooden briquettes. The influence factors of briquettes durability are numerous, but the paper noted that the compression is very important (near density, luster and cracks).

Durability of other woody materials such as wooden pellets and composites are two points of departure in establishing a methodology for determining the durability of wooden briquettes. The comparative study of two types of wooden briquettes presented in the paper highlights the importance of each influencing factor of the briquettes durability and their aggregation on the same type of wooden briquettes will lead to drastic destruction of briquettes with high durability. High durability of briquettes leads to higher losses during transport and storage at the beneficiary, in the form of dust and chips and if combined that with large differences in moisture contents the briquettes can be totally disintegrated.

#### REFERENCES

1. Borregaard Lignotech, *Pelleting Aids*, Available: <http://hysteriah.no/borregaard/testers.htm/>, (December, 2011).
2. Lowe, R. -Judging pellet stability as part of pellet quality, *Feed Technology*, 9.2, pp. 15-19, Available: <http://www.AgriWorld.nl/>, (2005).
3. Mitisor Al, *Tehnology of laminated products* (in Roumanian), Transilvania University of Brasov, Brasov (1967).



"HENRI COANDA"  
STEFANIK  
AIR FORCE ACADEMY  
ROMANIA



"GENERAL M.R."  
ARMED FORCES ACADEMY  
SLOVAK REPUBLIC

INTERNATIONAL CONFERENCE of SCIENTIFIC PAPER  
AFASES 2012  
Brasov, 24-26 May 2012

4. Tummerman M, Rabier F, Jensen P D, Hartman H, Bohm T - Comparative study of durability test methods for pellets and briquettes, *Biomass and Bioenergy*, vol 30, Issue 11, pp. 964-972, (2006).  
Science, The Pennsylvania State University, The Graduate School, Department of Agricultural and Biological Engineering, Available: [http://www.tow\\_thesis\\_final\\_rev2.pdf/](http://www.tow_thesis_final_rev2.pdf/) (May, 2010).
5. Wilson O., T. - *Factors affecting wood pellet durability*, Degree of Master of