Evaluation of Parameter Impact on Final Briquettes Quality

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Abstract. *This paper describes shortly evaluation process of parameter impact on final briquettes quality. At the beginning we present compacting technologies of the solid organic waste as briquetting or pelleting and also products of these technologies. In the middle of the paper we describe parameters that have great influence on briquette quality and design experimental pressing stend. Last part of this paper deals with experiment and evaluation of measured values.*

Keywords: Briquetting, Pelleting, Biomass, Briquette Density, Quality of Extrusion

1. Introduction

Biomass forms a big part of unutilized waste. Production of high-grade bio fuels - briquettes - is a convenient way how to energetically efficiently utilize the waste. Waste has to modify during the process of energetic upgrade. It is very important to know the influence of all parameters on the final quality of briquettes, which is evaluated by the density of briquettes. This report deals with evaluation of measured values that influence the final quality of briquettes.

2. Compacting technologies

Compacting technologies have been known for more than 130 years. The feature that all technologies of compacting – pelleting, compacting and briquetting – have in common is pressing of material under high pressure. Essential preconditions for compressed material to stay compact after pressing even without binder are appropriate setting of pressure and temperature inside the pressing chamber. Further precondition appears to be the maximal fraction size as well as allowable humidity of compressed waste. In the case that the mentioned values are exceeded, the waste needs to be crushed and dried out. The final products of briquetting, compacting and pelleting are briquettes of various shapes and sizes. The technology of compacting is not being described in the report, as it is not used to produce briquettes due to absence of endurance phase of applied pressure as well as absence of cooling phase. This fact is very important in biomass compacting.

Pelleting

Peletting is a progressive way how to compact the crushed and dried mass. It is a new and very progressively developing compacting technology, by which the dried wooden mass (biomass) or crushed wooden mass is processed by the compacting press under a very high pressure. Its introduction needs higher investment in technology purchase as well as investments from the customer side. The final products of the mentioned technology are pellets of cylinder-like shape. Pelleting machine is shown in Fig. 1. [1]

Briquetting

Briquetting is the most known and a widespread technology of compacting. The technology uses mechanical and chemical properties of materials which are compressed into the compact shapes (briquettes) without additive binders using the high pressure compacting. When, for example the biomass undergoes the process of briquetting, while high pressure and a temperature simultaneously act upon the mass, the cellular structures within the material release lignin, which binds individual particles into a compact unit. The briquetting can be used to compact the following materials: sawdust particles, wood shavings, bark, wood dust, straw, cotton, fabrics (natural materials, synthetic materials combined with the material containing lignin), paper, waste of raw material origin, etc. Briquetting press is shown in Fig. 2. [1]

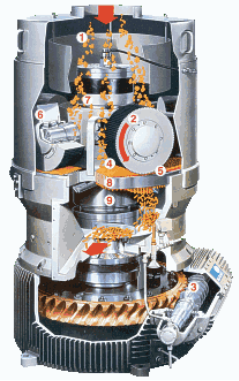


Fig. 1. Pelleting machine

Fig. 2. Mechanic crankshaft briquetting press

3. Parameters influencing the final quality of briquettes

The final quality of briquettes is influenced by many factors. The most significant effect have pressing temperature, compacting pressure, largeness of input fraction, kind of material, size and humidity of fraction. [4]

Compacting pressure is the most important factor having influence particularly upon the strength of briquettes. The strength of briquettes increases with increasing pressure within its strength limit and tendency to absorb atmospheric humidity during the long term storage is decreasing.

Pressing temperature belongs together with compacting pressure to the most considerable parameters, what means - that it has significant effect on the quality and strength of briquettes. It determines the lignin excretion by cellular structures within the wood. Lignin is released under certain pressing temperature, which has to be unconditionally reached to assure undergoing process.

Largeness of input fraction has also effect on compacting process. The bigger is input fraction, the higher is power output required for compacting. In spite of that, the briquette has lower homogeneity and strength. With increasing largeness of fraction, the strength of bonds is decreasing results in fast briquette disintegration in the process of burning (briquette burns down faster, which represents its disadvantage).

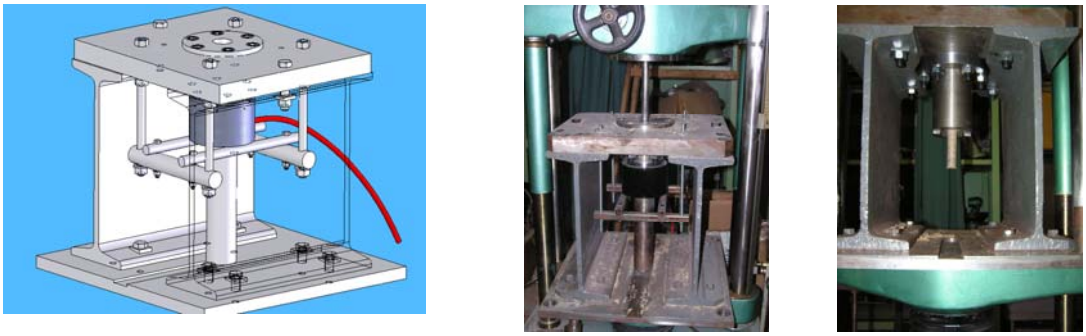
Humidity of input material has influence on lignin plastification. Water has positive role in growing tree because it is essential life condition for existence of every plant organism. Presence of water in tree that has been cut is undesirable. All recently known compressing technologies enable to compact material having relative humidity lower than 18%. The

humidity of 18 % appears to be the value optimal for compacting, because if the humidity is very small or in contrary very high, particles of material are not compact and briquettes may disintegrate.

4. Experiment and evaluation

At Faculty of Mechanical Engineering of Slovak University of Technology in Bratislava a stend has been designed and constructed and it serves to observe (measure) effects of compactig pressure, pressing temperature, humidity of input fraction and largeness of input fraction on quality of briquettes (see Fig. 3) [2].

The report presents the results of experiments, which were made with the same material, while above mentioned effects were changing. The aim of the experiments was to find out the effect rate of all important parameters on the quality of the briquette.



a) b) c)

Fig. 3. Experimental pressing stend
a) 3D model; b) produced pressing stend; c. pressing stage of a briquette

The measurements on a pressing stend were carried out using different values of individual parameters, which were analysed (see Table 1). The range of the values was obtained on the base of previous measurements. The final and in our opinion critical parameter to consider the quality of a briquette was its density, which ought to lie within the interval from 1 to 1.4 kg/dm^3. The density was evaluated by two steps. The first step was for a density value before stabilization and the second step was represented by density value after stabilization of briquette. The reason is that the density of briquettes is changing with time due to stabilization process and it seems to be important to understand the way that leads to the change as well as to quantify it. [3]

Table 1. Levels of measured parameters

Pressure	Temperature	Largeness	Humidity
p [MPa]	T [°C]	L [mm]	w [%]
95 - 159	85 - 115	1 - 4	8 - 12

On the base of measured data, the rate of effect of individual parameters on the final density value was determined. The method of expression of individual parameters effects was applied. Fig. 4 shows horizontal bar chart, which illustrates the influence of individual parameters. As it becomes evident from the chart, the critical parameters that have effect on the final density are the pressing temperature and humidity of compressed material before stabilization as well as after stabilization. [2]

Fig. 5 illustrates the dependence of density change on temperature change.

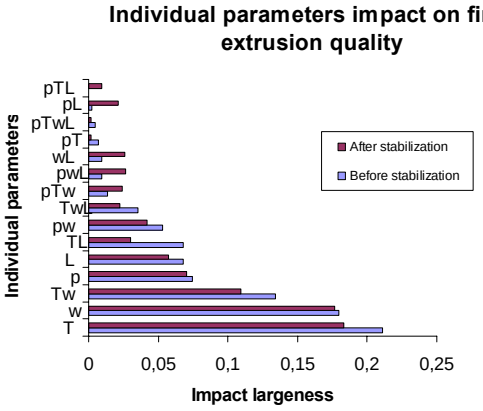


Fig. 4. Rate of individual parameters impact

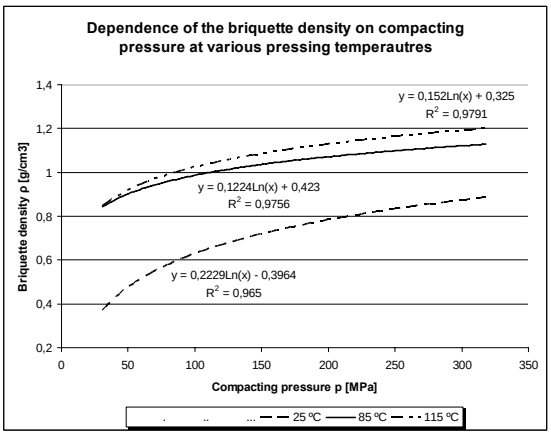


Fig. 5. Dependence of the briquette density on compacting pressure at various pressing tempereatures [2]

5. Conclusion

The main aim of the experiment was to identify the effect rate of observed parameters on the final quality of the briquette, notably the density of a briquette. By the individual steps we discovered that the most critical effect upon the briquette quality has the pressing temperature and then the humidity of material and mutual action of these two parameters. The results testify our hypothesis that compacting pressure, which may seem to be a parameter having the biggest effect on the final quality of a briquette, is minor in analyze of effects on briquettes quality.

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