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MECHANICAL PROPERTIES OF LIGHT COMPOSITIVE BIOBRIQUETTES

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Abstract. *Light compositive biobriquettes, except volume mass, possess some other properties which make them essentially different from heavy biobriquettes. Properties of heavy biobriquettes are: voluminity phenomenon, easy crashing in transversal direction, comparing to axial direction in which forming of briquette is done, great sensitivity to humidity, presence of particles removing from briquette surface and reducing of intercorpuscular connection forces. These phenomena are not present at light compositive biobriquettes. Pressure resistance examinations of light compositive biobriquettes, show exceptionally satisfactory results as it is shown in this paper.*

1. INTRODUCTION

In Yugoslavia does not exist special standard which refers to biobriquettes examination, heavy and light compositive biobriquettes. For examination of biobriquettes pressure resistance of all methods, only JUS B. H8. 376 is available, which refers to solid mineral fuels, such as coal briquette, by name"Determination of pressure resistance". In the lack of other normative methods, this standard is used - for more precise research about mechanical properties of heavy and light compositive biobriquettes. These aknowledgements are necessary for determination ways of handling, packing and storaging of light compositive biobriquettes. The reason for this is possibility that under certain conditions light compositive biobriquettes may be concurrent to heavy biobriquettes, but very challenging like economical-ecological-energy fuels, too [1].

2. MATERIAL AND METHOD

As material for researchings here are used light compositive biobriquettes with

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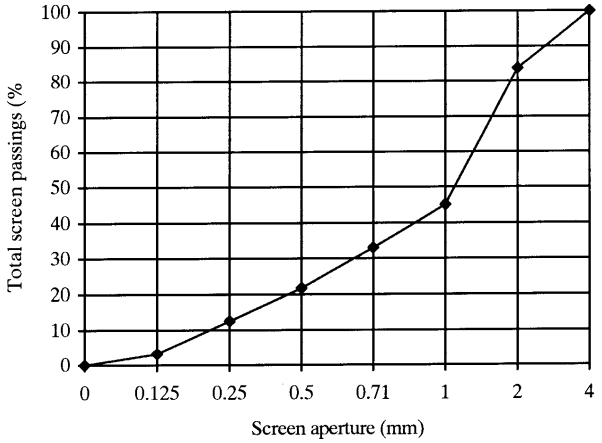
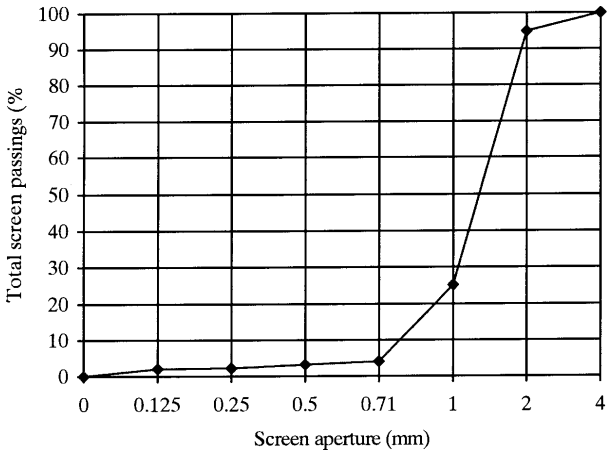
adherents and additives such as coal dust of brown-lignite coal "Soko", calcium-carbonate from lime and non-metal industry "Ostrovica", sacked hydrated lime of trade origin for comercial purposes and biomass [1]. As biomass component are used: beech sawdust, ash chipping, nut shell , rice shell, huskus and cuttings of grape vine.

During the production of the compositive biobriquettes on the basis of lignocellulose pulp, coal dust, calcium-carbonate and hydrated lime, are established molar rarios calcium to sulfur, Ca/S: 1; 2; 3; 4 and compositive briquettes paper-coal dust without adding of third component. Material for researchings is in details descripted in [1, 2, 6, 7]. In all examinated compositives lignocellulose pulp is 0,5 and mass part of other adherents is 0,5 too.

Screen analysis of used coal is shown on graph 1 and screen analysis of limestone on graph 2.



Graph 1. Screen analysis of brown-lignite coal "Soko" from mine "Čitluk"



Graph 2. Screen analysis of limestone from lime and non-metal industry "Ostrovica"

Basic characteristics of biomasses which are used as components in light compositive biobriquettes:

- *rice shell* - natural size, nongrinded, obtained after peeling treatment and with bulk volume mass of 83 kg/m^3;
- *cuttings of grape vine* - diameter of cutting is in natural size of ∅ 5–15 mm and lenghts are reduced on 10–20 mm, material is homogenized in pulp manual, bulk volume mass of non-reduced cuttings is 65 kg/m^3;
- *huskus of grape vine* - obtained from vineyard "Sićevo", of Niš grape vine district.. Here are used two kinds: before and after fermentation. Cuticle and seed are included in huskus and they are not separated from each other. Material is taken as samples from landfill after 6 months of laying. Material is not grinded and its bulk volume mass is 148 kg/m^3;
- *beech sawdust* - is obtained from cutting process on saw-mill. Granulation is 0–2 mm and bulk volume mass is 169 kg/m^3;
- ash chipping - is obtained from plane production. Parts are shapeless, unequal size, often curved in curls. Precise definition of size is not possible but it could be descripted that average size is 1×20×20 mm. Bulk volume mass is 28 kg/m^3;
- *nut shell* - is obtained after nucleus cleaning. Parts are unequal size, bulk volume mass of 253 kg/m^3.

In lack of precise method as examination method is used normative method JUS B. H8. 376 from 1982. This standard refers to solid mineral fuels - coal briquettes - determination of pressure resistance. Other methods are descripted in researching results. Researchings have been done in laboratory of MIN institute and laboratory for combustion on Occupational Safety Faculty in Niš.

3. RESULTS

Examination process by JUS B. H8. 376 anticipate putting of examination briquette between cylindrical press butts in that way so butts may react in the centre of briquette surface. Next step is press switching and than uniform pressure growing till the crashing of briquette, whereby maximum pressure is is write down.

Examination results are as abstract from protocol shown in table 1. and on graphs 1, 2, 3. The most significant conclusion is that in pressure range from 1 to 4 MPa there wasn't briquette crushing. Briquettes sustained certain permanent plastic deformations, such as reducing of cylinder height and cylindrical shape has changed into keg. Samples apprehended elastic properties so after removing from press height is somewhat magnified. During the pressure reaction inside briquettes there was crushing and pulverization of incorporated rigid particles of biomaterial but there wasn't briquette crushing. This, before all refers to stones and cuttings. However, briquette compactivity, in conditions of strong heterogenous structure such as compositives with cuttings, ash chippings and nut shell, set-back after sustained plastic deformations thanks to space net of cellulose fibres.

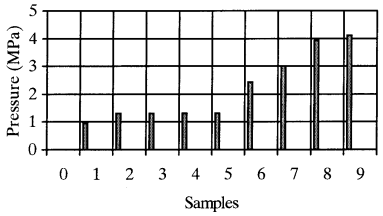
Comparing results of these examinations with examination of Radovanović [5], it can be noticed that on samples of light compositive biobriquettes which he was examinated there is crushing at surface pressures from 0,7 to 3,8 MPa. For these samples, however,

aren't specified mass parts in composite.

The least deformations (in sense to obtain keg shape of briquette) are achieved on light compositive biobriquette with coal dust and sulfur sorbent. In this case is apprehended cylindrical shape of samples but deformation degree expressed per relative reducing and the greatest is ε = 66 %.

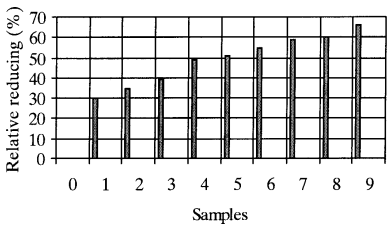
Table 1. Results of pressure resistance examinations of light compositive biobriquettes [6]

Ordinal	Briquette structure	Pressure (MPa)	ε (%)	Comment
1	Paper	4,12	49	Apprehended cylindrical shape, regular cylindar partly pulped into skew, there is no cracks and crushing
2	Paper + coal dust + $CaCO_3$	3	55	Apprehended cylindrical shape, regular cylindar partly pulped into skew, there is no cracks and crushing
3	Paper + rice shell	1,31	66	Apprehended cylindrical shape, regular cylindar partly pulped into skew, there is no cracks and crushing
4	Paper + grape vine cuttings	1,33	59	Cylindrical shape pulped into keg, there is no cracks and crushing except breaking and crushing of incorporated grape vine cuttings inside briquette during the examination
5	Papir + grape vine huskus	1,33	60	Apprehended cylindrical shape, regular cylindar partly pulped into skew, with cracks appearance but no crushing
6	Paper + beech sawdust	2,43	51	Apprehended cylindrical shape, regular cylindar partly pulped into skew, there is no cracks and crushing
7	Paper + ash chippings	1,33	39	Apprehended cylindrical shape, regular cylindar partly pulped into skew, there is no cracks and crushing
8	Paper + nut shell	0,94	33	Cylindrical shape pulped into keg, there is no cracks and crushing except breaking and crushing of incorporated nut shells inside briquette during the examination
9	Paper + coal dust + + hydrated lime	3,93	35	Apprehended cylindrical shape, regular cylindar partly pulped into skew, there is no cracks and crushing



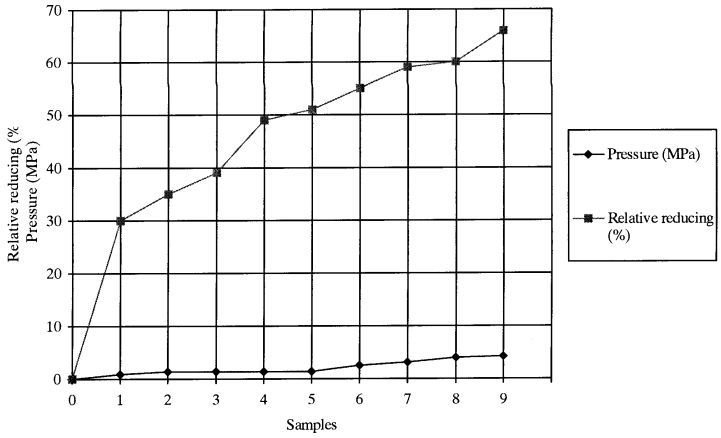
1.Paper-nut shell
2.Paper-grape vine huskus
3.Paper-grape vine cuttings
4.Paper-ash chippings
5.Paper-rice shell
6.Paper-beech sawdust
7.Paper-coal dust-lime stone
8.Paper-coal dust-hydrated lime
9.Paper

Graph 3. Surface pressure by which is affected to samples of light compositive biobriquettes [6]



Paper-nut shell
Paper-coal dust-hydrated lime
Paper-ash chipping
Paper
Paper-beech sawdust
Paper-coal dust-limestone
Paper-grape vine cuttings
Paper-grape vine huskus
Paper-rice shell

Graph 4. Relative samples's reducing of light compositive biobriquettes [6]



Graph 5. Relative samples's reducing of light compositive biobriquettes and pressure[6]

One of properties of light compositive materials is possibility of engrave treatment. This property is more outstanding at compositives where adherents are with smaller granulation (sawdust, coal dust, huskus). At light briquettes with larger particles incorporated and with more heterogenous property (nut shell, cuttings) during the engraving there is lax of larger parts within net of lignocellulose fiberes so on the intersection it is possible to have spilling of cut solid particles. Material is possible to treat with perforation as special way of engraving and hammering of nails as well as paddle-wheel twisting too (tree for example). On the extern surface of deformated samples there is no crumbling, crushing, and adherent spilling.

Without some concrete measurements, by intuition it is possible to forebode properties of these materials such as good thermoisolation, vibrateisolation and apsorption properties propitiatory for noise reclaiming. Researchings on the examination of these properties, should be continued.

4. CONCLUSIONS

Based on results of shown examinations of light compositive biobriquettes it is possible to abstract following conclusions:

- in surface pressure range from 1 to 4 MPa there is no samples crushing;

- briquettes are liable to elastic and plastic deformations, relative compression is achieved to 66% at pressure 1,31 MPa for samples paper-rice shell and material after deformation is keeping elastic properties;
- light compositive biobriquettes with adherents smaller granulation are specially good for engraving treatment and those with more heterogenous structure may engraving too, with possibility that on intersection lapse certain percentage of larger particles;
- on samples it is possible to perforate, hammering nails and paddle-wheel twisting;
- there is suggestion for further researching of these material for studing their termoisolation, vibroisolation and apsorptional properties;
- also there is a need for further researching with goal to find the most satisfactory ratios between paper pulp and adherents.

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MEHANIČKA SVOJSTVA LAKIH KOMPOZITNIH BIOBRIKETA

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Laki kompozitni biobriketi imaju, pored male zapreminske mase i neka druga svojstva koja ih čine suštinski različitim od teških biobriketa. Teški biobriketi imaju sledeća svojstva: pojava "voluminoznosti", lako lomljenje u poprečnom pravcu u odnosu na aksijalni pravac u kome je vršeno formiranje briketa, velika osetljivost na vlagu, prisutnost skidanja čestica sa površine briketa i popuštanje interkorpuskularnih sila veze. Ovih pojava nema kod lakih kompozitnih biobriketa. Testovi na otpornost prema pritisku lakih kompozitnih bioriketa pokazuju izuzetno povoljne rezultate, što je prikazano u ovom radu.

Ključne reči: *biobriket, biomasa, energija, gorivo*