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# REDUCTION OF ENVIRONMENTAL POLLUTION BY USING BIOBRIQUETTE

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**Abstract**. *In this paper are presented own experiences in researching of composite biobriquettes production possibility by so called "wet process" and ecological, economical and energetical advantages of their use. This paper represents the results of own researching in Combustion laboratory of Occupational Safety Faculty.*

**Key words**: *biobriquette, ecology, energy*

## 1. INTRODUCTION

The goal of biobriquette use entire analysis is to point out: limitation need of fossil fuel use and on the other hand larger biomes use with contemporary forests protection. The other words, point is on need of using only the vegetative potential. The biomes itself (even it is not in forms characteristic for annual growth) has series of inaptitudes for use, such as: collecting, packaging, storaging, keeping and preparation for final purpose, periodicity, indentency in space, bad form and high humidity, low volume mass, high participation of transporting and storaging expences and low heat value guide down to volume unit ($kJ/m^3$).

However, fito mass and transformed products of plant cultures which represent vegetative potential, have whole addition series of bad features characteristic for every plant species, particularly. For example:

- cuttings from viticulture (bad and diverse form, high humidity, low volume mass);
- cuttings from fruit growing (low volume mass, irregular and diverse branchery);
- pits (at the time of processing humidity is still high, heterogenous structure – pit and nucleus, bad rinfuz state for combustion, bad preconditions for briquetting, special bars for combustion);
- forest branchery (shrubberies from "clean cutting"–diverse of forms and dimensions,

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low volume mass);
- cane (bad structure of the trunk for final briquetting, i. e. crushing);
- seed shells of industrial plants (in mixture with dust is explosive, briquettes are breaking after solicing because of weak interparticle connection forces) etc.

Cumulatively, all of these bad features together, lead to abandon of use of basic rinfuz biomes forms from vegetative potential domain. However, if basic demands are set which biofuel prodeced from these resources should hasa and if technological possibilities for their production are explored, there are solutions.

What demands should be satisfied by possible technology for available resources with mentioned shortages, so its product can be useful? Demands are:
- exceeding the previous demand that biomes particle should be 1 – 3 mm,
- elimination of biomes humidity as limitation factor,
- exceeding the problem of heterogenous structure of used biomes mixtures (for example pits and straw),
- to make up compact form whose surface hardness will not change in biobriquette storaging period,
- to eliminate the problem of interparticle connection forces weakening between incorporated particles and to protect from biobriquette breaking and disintegration,
- to provide possibility of good connection between biomes and fossil fuels adherents during the use of waste fossil fuels which are not attractive for other purpose (coal dust, liquid fuels mud),
- to provide sulfur sorbent in the case of significant sulfur presence in fossil fuels adherents,
- to program real adherent content in the case of special demands concerning to heat power, color and length of flame.

In Combustion laboratory on Occupational Safety Faculty in Nis, research team has, more or less, overcome certain biomes inaptitudes for their use through some produced biobriquette kinds and reconciled confront features which disable their production. Basicaly, under biobriquette is meaning product of briquetting technological process – compact biomes form which has far higher volume mass, comparing to biomes volume mass from whom biobriquette is made. Yugoslav standard D.B.9.021 under energy briquette is meaning product produced by lignocelulose material briquetting process. The briquetting process itself, means compression of lignocelulose material into lower volume by presses with open or closed matrix.

## 2. BIOMES APPLICATION IN BIOBRIQUETTE FORM

The review of basic reclaimed biobriquettes kinds (produced in Combustion laboratory on Occupational Safety Faculty in Nis), practicaly can be defined through following 4 types:

1. heavy biobriquettes produced from biomes in small pieces,
2. heavy biobriquettes produced from unprepared biomes (branchery, trunks,…) without use of connection means,
3. biobriquettes with paper pulp as connection mean,

4. new biobriquette kind with halfcelulose as connection mean and
5. special biobriquettes.

In scope of every of here defined biobriquettes kind, is possible to separate solitar and multiple (composite) biobrtiquettes.

*Solitar biobriquette* is biobriquette produced by using only one biomes kind which can be choped up or in form of branchery, cuttings or trunks.

*Multiple (composite) biobriquette* is biobriquette produced by using more than one biomes kind or by puting other adherents such as sulfur sorbent, or to perform some features. This biobriquette can belong to all explored basic groups.

Concerning to volume mass which can be reached at some biobriquettes kinds, authors suggest following classification:

1. light $\rho_{BR} < 400$ kg/m$^3$,
2. medium 400 kg/m$^3$ < 1000 kg/m$^3$,
3. heavy $\rho_{BR} > 1000$ kg/m$^3$.

In production of these briquettes the authors are using term "forming pressure". This means pressure of tool patrix on biomes material, but not the pressure in hidraulic or pneumatic instalation of briquetting device.

*Heavy biobriquettes* have volume mass which is the most often over 1100 kg/m$^3$.

Briquetting process, itself, means that biomes is going to be exposed to high pressure, with contemporary biomes material moving through tool so its temperature is raising. By this way, activated physical-chemical processes lead to thermoplastic deformations of lignocelulose material and granulated material particles binding into compact form – biobriquette [6]. Forming briquettes from unprepared branchery and trunks up to 300 MPa [6] and for pressures for briquettes from prepared biomes are up to 20 MPa.

Fig. 1. Heavy biobriquette made of unprepared biomes (grape cuttings)

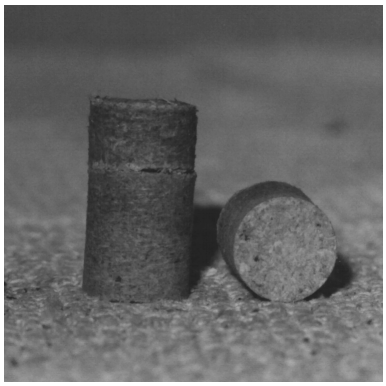

Fig. 2. Heavy biobriquette made of prepared biomes (beech – sawdust)

Light briquette forming technology essentially differs from heavy briquette forming technology. As a basic forming briquette material here is used old paper (and industrialy recycled, too) in the form of lignocellulose pulp in water suspension, with or without additions of another biomes. Toward to increasing briquette heat power, usefullness or

other properties it's possib;e to put in water suspension other biomes too (cortex, sawdust, needles, branchery, huskus and cuttings of grape-vine,…), coal dust or other additives. Important detail is possibility to incorporate dregs of stone fruits (great amounts from fruit industry) into light composite briquette mass. It's possible to use pins of sour cherry, peach, appricot and pin shells of wal-nut, almond, hazel-nut,… In this case from these mixtures it's possible to produce light composite biobriquettes by pressing of suspension in appropriate tool with pressures which are not higher than 0,3 – 0,5 MPa [6,7]. Pressing is displacing the greatest amount of water and the rest is removing by drying on the air.


Fig. 3. Light composite biobriquette from grape-vine cuttings and paper pulp as binding mean

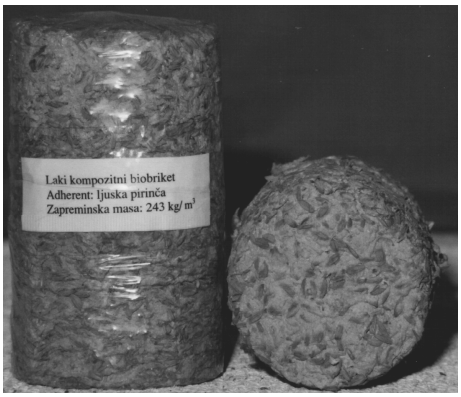


Fig. 4. Light composite biobriquette from rice shell and paper pulp as binding mean

### 2.1. Advantages and disadvantages of light composite biobriquettes

Light composite biobriquette presents alternative solution to heavy briquette or heavy briquette produced by high pressures with minimal grinding [6]. In contrast to heavy briquettes, light composite biobriquettes possess certain:

a) *advantages:*
- cheap technical solution of the briquetting device;
- it's possible briquetting of material which makes composite heterogenic structure with particles greater than 10 mm (depending on briquette size);
- it is not necessary previosly biomes drying to some requisite moisture;
- requisite pressure is quite lower regard to pressure requisite for heavy biobriquettes forming;
- it's possible to incorporate sulfur sorbent;
- it's possible to store them without problems which follow storiging of heavy biobriquettes (voluminivity, swollening owing to humidity and eventual disintegration) [6].

b) *and disadvantages:*
- producing process is connected with preparation of pulp on the basis of paper and water which demands a certain time period for paper disintegration and

homogenization of composite;
- after wet briquette forming a certain time period is needed for drying, which is relatively long for air drying. Drying time depends on briquette dimensions and by author's experience, for briquette $\phi\ 82 \times (250 - 300)$ mm, is max. 10 days;
- if there is artificial drying it means additional expence [6].

### 2.2. New kind of composite biobriquettes with halfcellulose as binding mean

Authors' researching on technique-technological possibilities of light biobriquettes producing, their physical characteristics, mechanical properties and usability values are sublimated in papers [1,2,7,8,12]. These experiences refer to light briquettes whose production is based on paper pulp, as binding mean. Seeing that, the paper is, in some way, strategic material (it's better to say deficit material), so, because of that paper is not suitable for this purpose [8].

Because of these reasons, possibility was seeking for paper to be changed with some other material. New material should satisfy following conditions:

1. Production technology must be simple enough. It's desirable for process to be "wet" and without condition of prior composite components drying;
2. Whole material should be combustible, and products should be equivalent, by the structure to the products from biomes combustion;
3. Material should enable incorporation of wide opus and sortiment of biomes and classical fossil fuel wastes and
4. Depending on possibility, mass and energy concentration in volume unit of such composite biobriquette should be as greater as possible.

Solution for these demands is found in production of one new kind of light composite biobriquettes, which are produced in Combustion laboratory on Occupational Safety Faculty in Niš.

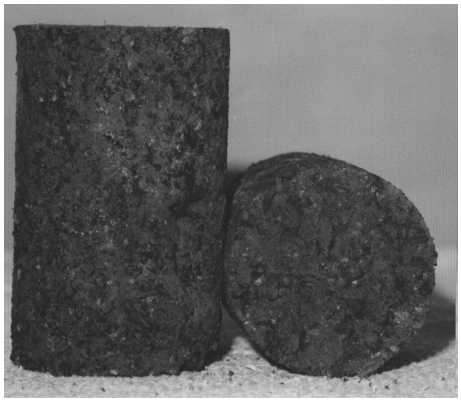

Fig. 5. Composite biobriquette from coal dust with halfcellulose as binding mean

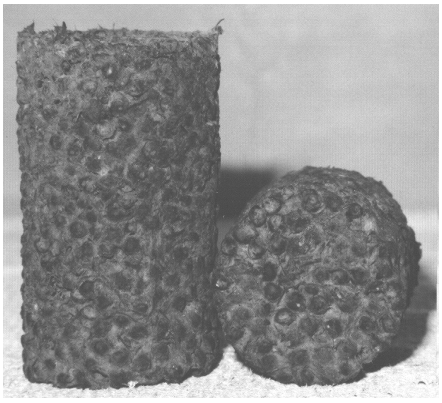

Fig. 6. Composite biobriquette from sour cherry pins with halfcelulose as binding mean

In this technology is used halfcellulose as binding mean. Composite biobriquette

offers extra possibilities for incorporating: biomes (as basic material) coal dust as waste from separations and sulfur sorbent as an additive. By this way is produced fuel, for whose production is not necessary to use glue or stuff, whose heat power greatly increases with various additives which the most often can be treated as waste - secondary material. Additive material can add in goal to perform mechanical, thermal, ecological or esthetical properties of biobriquettes. Produced by this way biobriquettes have volume masses from 720 to 830 kg/m$^3$, depending on halfcellulose part and surface pressure of tool on composite material, as well as some other properties which make them essentially different from heavy and classic light briquettes [8].

### 2.3. Special biobriquettes

Special biobriquettes are product of dry process briquetting, where as a binding mean is used some higher members of saturated carbohydrates. These biobriquettes belong to groups of multiple medium and heavy biobriquettes. Here are exploremultiplebilities of biobriquette production for restricted combustion in hearths, with in advanced defined heat power, time of combustion and flame color [11].

Fig. 7. Special biobriquettes from beech sawdust

Fig. 8. Special biobriquettes from sunflower shells

## 3. RESEARCHING VOLUME

Within these researching, as biomes materials 26 biomes kinds, 2 fossil fuels wastes and 3 kinds of sulfur sorbents are used. From all biobriquette kinds is produced 117 briquette types. They were used for exploring of physical properties, hardness, technique-technological production possibilities and for experimental combustion.

Because of limited number of pages for paper presentation, authors are forced to shaw previous scope of researching through citation on references.

Material and researching methods are detail reviewed in references [1,6,7,8].

Researching include, primarily, technique-technological production possibilities of mentioned biobriquette kinds and within these, determination of:

– cover densities, volume masses and screen analysis [1,6,9,10];
– exploitation coefficient of storage space;
– technical analysis facts [3,4,6,8];
– heat powers [6,9,10];
– minimal forming pressures [6,12];
– hygroscope humidity content in analytical specimen [6];
– pressure resistance [1,2] and
– Dependence of pressure tension from volume mass and binding mean part and its kind [12].

Because of great amount of research results here is impossible to shaw all results, so the most important are sublimed in conclusions.

At the moment of material processing for this paper, researching is in phase of specimens experimental combustion, which are mentioned here.

## 4. CONCLUSIONS

According to researching results presented in this paper, as well as authors' results of this paper in references [6,8] conclusions are following:

1. Biomes represent qualitative energy resource especially if it is transformed into biobriquette. Heavy biobriquettes classification by the norms of Yugoslav standards shows that 37,5% biobriquettes of explored biomes belong to extra class and the others of 62,5% belong to I class of energy biobriquettes [6];

Detail technical analysis of light composite biobriquettes with paper pulp as binding mean is Shawn in [5,6,8]. Here is emphasize only the fact about its heat power:

– heat power is on the level of high-quality lignite or brown-lignite coals, from 17,2 to 18,9 MJ/kg;
– volume heat power (reduced to cover light composite biobriquettes is from 4970 to 9000 MJ/m$^3$) which means that it is 2 to 10 times higher comparing to basic biomes;
– and light composite biobriquettes pulp/coal/limestone and pulp/coal/hydrated lime according to results of technical analysis can be interesting energy fuels (average heat power is about 17 MJ/kg, volume heat power is about 8000 MJ/m$^3$. Incorporated sorbent into biobriquette structure is not only the hypothesis for smoke gas desulphurization but it seems to be highly influencing to biobriquette hardness.

2. Volume mass of light composite biobriquettes is high enough so volume heat power is competitive to classic fossil fuels and heavy biobriquettes [8,12].

Volume masses of light composite biobriquettes based on paper pulp are from 310 to 500 kg/m$^3$. Volume masses of light composite biobriquettes with coal dust and sulfur sorbent in form of $CaCO_3$ are from 390 to 600 kg/m$^3$ and cover volume masses are from 312 to 435 kg/m$^3$. When the sorbent is hydrated lime volume masses are from 453 to 537 kg/m$^3$ and cover volume masses are from 305 to 405 kg/m$^3$. The briquettes are compact, do not erode, do not break in drying phase, there are no voluminivity, they can be cut, and chop.Saving of storage space (based on biomes in rinfuz) is from 44 to 88%. All here analyzed specimens have pulp part of 0,5 and other adherents and additives have mass part of 0,5.

Volume masses of new composite biobriquette kind based on halfcellulose as binding mean are from 720 to 830 kg/m$^3$.

3. Production technology is relatively simple and cheap;
4. It's possible to bind materials of heterogeneous structure;
5. Here is possible to use components which are waste materials in other technologies. Principally, these composite biobriquettes have 3 significant E characteristics: economical, ecological and energetically;
6. In composite is possible to incorporate sulfur adherent with molar ratios Ca/S from 1 to 4 [1,7,8,11];
7. Materials which are biobriquette components don't need to be especially prepared: grinding is reduced to minimum, components' granulation in form of coal particles may be from 0 to 20 mm, fruit pins in natural size and cuttings and Braintree with diameter and length to 30 mm [6,13].

Authors hope that their researching will help to produce a new kind of ecological, economically worthwhile, energy fuel based on wide opus of combustible waste materials. Their use should significantly eliminate categorized risks because fossil fuels use.

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# SMANJENJE ZAGAĐENJA ŽIVOTNE SREDINE PRIMENOM BIOBRIKETA

**Dragan Mitić, Emina Mihajlović, Bratimir Nešić, Batrić Milanović**

*U radu su izložena sopstvena iskustva u istraživanju mogućnosti izrade kompozitnih biobriketa takozvanim mokrim postupkom kao i ekološke, ekonomske i energetske prednosti njihove upotrebe. Rad predstavlja rezultate sopstvenih istraživanja u Laboratoriji za sagorevanje Fakulteta zaštite na radu u Nišu.*