# BRIQUETTING OF BROWN COALS WITH A BINDING AGENT MODIFIED AMYLUM WITH SOLUBLE COLOPHONY

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### ABSTRACT

Possibilities of modified amylum with soluble colophony are investidated at briquetting of brown coals. Performance indices of briquettes are expressed by the strenght indices of briquettes and their moisture resistance. A combined action of the binding agent modified amylum with soluble colophony with an additive of hydrated lime in quantity of 2 to 6% and aluminium sulphate in quantiti of 2 to 6% is investigated. Practical interest represents the investigation of briquettes for compressive strenght of one week period.

#### INTRODUCTION

Briquetting without binding agents of fine-grained coal waste of brown coals and coals of more advanced degree of coalification does not apply in practice.

Qualities of the binding agents, as their market value, are decisive at use of one or other binding agent.

Popular used binding agents are :

- organic matters : coal-tar pitch, oil bitumens, sulphite-cellulose liquor etc.

- inorganic matters : cement, gypsum, lime, water glass etc.

The inorganic matters like binding agents allmost do not apply in briquetting as they increase the ash content and decrease moisture resistance of the briquettes and their heat value. [1], [2]

About some organic binding matters used in the past it is established that they are dangerous of cancer and they do not reply of the ecological reguirements.

The advanced trends of search and use of organic matters like binding agents are mainly to pitches, dextrin, molasses, amylum, synthetic received organic compounds etc. [3].

It is known from the literature sources that briquettes with a binding agent like amylum and molasses are not moisture resistant and briquettes with a binding agent like peat and sugar solution have low streght indices.

### THEORETICAL PART

The modified amylum with soluble colophony (MASC) uses like a binding agent in paper industry like 10 % water solution. The colophony is hydrophobic and insoluble in water. It is used for hydrophobization of paper and cardboard surfaces, known in plactice like a sizing process. The use of the colophony for sizing is impossible in its natural appearance.

Its leading to the suitable state for the sizing process of paper becomes by saponification with sodium hydroxide (NaOH) or a fused soda ash (Na<sub>2</sub>CO<sub>2</sub>) according to the reactions :

$$C_{19} H_{29} COOH + NaOH = C_{19} H_{29} COO Na + H_{20}$$
 (1)

In both cases as result of saponification of the insoluble abietic acid form sodaic resinate. Their fixing are made by addition of aluminium sulphate in excess.

(2)

The aluminium sulphate influences positively on the sizing by means of its own metalions.

The residual sulphuric acid holds up necessary pH of the medium in an interval 4,5 - 5,5.

### EXPERIMENTAL PART

### Technique and materials

For holding up of investigation in laboratory conditions about briquetting of brown coals from the town of Pernik with a binding agent like modified amylum with soluble colophony is used a sample of the following characteristic :

-Initial dampness, %	20,3
- ash content of dry matter,%	26,3
<ul> <li>sulphur content in dry matter,%</li> </ul>	1,2
- caloricity, kcal/kg	4200



Figure 1. Granulometric characteristic of the coals of a Pernik's mine

The technique for holding up of the investigation is next : Certain quantity of the coals (45 g) mixes with modified amylum with soluble colophony (MASC). the influence of the hydrated lime is investigated joint with MASC. The quantity of the additive of hydratedn lime is changed in an interval from 2 to 10 %. The mixture homogenizes well by stirring and it dumps in a pressform. It closes by the upper fixed piston and presses at pressure to 138 kg/cm<sup>2</sup>.

The received briquette releases of the pressform after taking down of the upper pistin and the lower piston moves through an additional element. So the briquette pushes out from the cylindrical form. The strenght indices define after staying 2 hours. In orderto have compatibility between the received briquettes with a different content of binding agents, briquettes are prepared without a binding agent.

The defining of the strenght indices of the received briquettes accomplishes by following technique. Ten nombers briquettes are taken and weighed out to an accuracy of 0.1 kg. Every briquette falls from height 2 m. over a metal plate with thickness 15 mm. and side boards high 200 mm. it the briquettes after the first falling down do not destroy, they fall down to destruction one more time, twice and so on. The throwing does not repeat in case, that the received pieces are smallar than 25 mm. after destruction at the first falling down.

### **Experimental equipment**

The investigation on briquetting is realised by means of a laboratory type press. It is manufactured in the technical laboratory of the University. The press form a briquette at one-sided pressure feeding in a vertical direction and it ensures a pressure to 138 kg/cm<sup>2</sup>.

The pressform is cylindrically formed by an upper fixed piston and a lower mobile piston and give a possibility to receive briquettes with a diameter 45 mm and a height 65 mm.

#### Experimental results



Figure 2. MASC, % + 2% hydrated lime

In figure 2 are given the experimental results reflecting the relationship between the content of MASC and a constant additive of 2% hydrated lime and numbers of fallings. The optimal quantity of MASC is 6% at which the received briquettes are thick, without cracks, with increased "green " strenght. They are not loose and they are economic advantageous.



Figure 3. MASC 6% + hydrated lime,%

In figure 3 is displayed the relationship, between the consumption of hydrated lime with constant quantity MASC 6% and the numbers of fallings.

The received results show that the optimal content of hydrated lime is 2-4 %. Then the briquettes are mechanical strong and moisture resistant.

In figure 4 is displayed the relationship between strenght indices of briquettes established at usage of a binding agent MASC 6% and 2% hydrated lime and the time of outage of briquettes.



Figure 4. An investigation of briquettes of outage MASC 6% + 2 % hydrated lime



Figure 5. MASC 6% + Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>, % + 3% hydrated lime

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In figure 5 in a graphic mode is expressed the relationship between the used binding agents 6% MASC, 2% hydrated lime and aluminium sulphate ( $Al_2(SO_4)_3$ ) of 3 to 6 % and mechanical characteristics of the briquettes.

The laboratory experiments investigate the influence of modified amylum with soluble colophony and hydrated lime upon the qualitative indices of briquettes.

# DISCUSSION

Results which are received after laboratory investigation on briquetting wich a binding agent modified amylum with soluble colophony of brown coals from the town of Pernik proof, that the briquetting ensures the receiving of of briquettes with improved mechanical characteristicsand moisture resistance.

The optimal quantity of a binding agent from the point of view of the technology is 6%. Briquettes with MASC under 4% do not receive which is due of partially and obviously insufficiently soaking of the surfaces of coal particles. The utilization of MASC about 6% is unprofitable from an economical point of view of the advanced marcet prices.

The utilization of hydrated lime in the process of briquetting has an positive effect which expresses in warming of the briquettes at their reaction with the available moisture from solution of the binding agent. Bonds between coal grains reinforce at the carbonization. The decrease of the free moisture between the particles in the briquette also is not less important.

The best results as regards to the mechanical strenght give briquettes formed with 2 - 4 % hydrated lime. The moisture resistance is the highest at these values. The increase of the quantity of the hydrated lime in briquettes to 8-10 % makes worse their solidity because of presence of a residual calcium base which reacts subsequently with the atmospheric CO<sub>2</sub>. Briquettes received at content of MASC 6% and hydrated lime are investigated for a change of mechanical characteristics after outage at a room temperature 10°C. After 4 days outage according to the graphic relationship 4 reach maximum number fallings from a height 1,5 m according to an Bulgarian standard over a hard surface. The trend to decreasing of the mechanical characteristics of briquettes is available after the fourth day.

The received briquettes with a binding agent MASC reply to the requirements of a Bulgarian standard about dampness which is in the interval from 10,9 to 13% and ash which is from 20,8 to 22,9 %. The compressive strenght is between 7,3 and 8,6 Mpa and the strenght of falling is in the limits 80-91%.

Analogue investigation are accomplished with briquettes formed without a binding agent.

The briquettes without a binding agent have very low values of strenght indices. The combined action of MASC and hydrated lime creates good conditions for receiving of briquettes from the Pernik's brown coals. They have high moisture resistance and high strenght of falling. An additive positive effect give the presenceof hydrated lime in the briquettes in the process of the burning. This effect expresses in neutralization of the received sulphur oxides.

## CONCLUSION

The action of modified amylum with soluble colophony is investigated like a binding agent at briquetting of brown coals. The received briquettes are with good mechanical characteristics and moisture resistance. The optimal quantity MASC is from 6%.

The combined action of MASC and hydrated lime is investigated too. An established optimal quantity is 2-4% hydrated lime. The received briquettes from this combination have improved moisture resistance and strenght of falling. The addition of aluminium sulphate improves the mechanical characteristics of briquettes which are received with a binding agent MASC and hydrated lime.

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