COPMPOSITE FUEL ON THE BASIS OF HYDROLYTIC LIGNIN AND OIL PRODUCTS

T. Savitskaya, D. Hrynshpan, N. Tsygankova, T. Nevar, I. Reznikov
Belarusian State University, savitskayaTA@bsu.by
G. Telysheva. A. Arshanitsa
Latvian State Institute of Wood Chemistry

Hydrolytic lignin is produced at the chemical treatment (acid hydrolysis) of wood and other lignocellulosic biomass as a waste product. Biosphere has an estimated $300x10^9$ metric tons of lignin with a $20x10^9$ metric tons annual biosynthesis rate. It has different spheres of the use: in energy sector for the production of briquettes, pyrolysis bio-oil and fuel gas; in chemical industry as a sorbent for purification of industrial effluents; in agriculture for the production of organic fertilizers and herbicides and so on. There are some trends of research of the alternative uses of lignin including the production of activated carbon, carbon fibres and phenols as well. Lignin based products are very attractive because of REACH as a possible barrier for future market development is not specific to them. The preferred use of lignin is likely to depend largely on the world price of both biomass and of oil. From this point of view the production of composite fuel on the basis of hydrolytic lignin and worked-out oil products makes sense. Oil spills and worked-out oil products can be used as the oil component of the composite fuel.

Energy and lignin situation in Belarus is the following: fossil fuels constitute no more than 15% of the needs. Belarus imports 20-30 % of the electric energy. The wood fund of the republic makes more than 9,4 million hectares, the wood stock on a root is estimated at 1,6 billion cubic meters. Belarus is included into ten the leading wood states of Europe. Three millions of tons of hydrolytic lignin are in dumps and create the environmental awareness.

Hydrolytic lignin is a sawdust mass with humidity 55-60%, containing lignin till 80%, polysaccharide and etc. The content of pure lignin in this matter reaches 40-88% and the percentage of solid carbon in hydrolytic lignin reaches 30%. This is a highly porous material with moisture content from 65 to 70%. It is a conglomerate of different compounds, mono-and polysaccharides, organic acid, tar, ash, wax and other components.

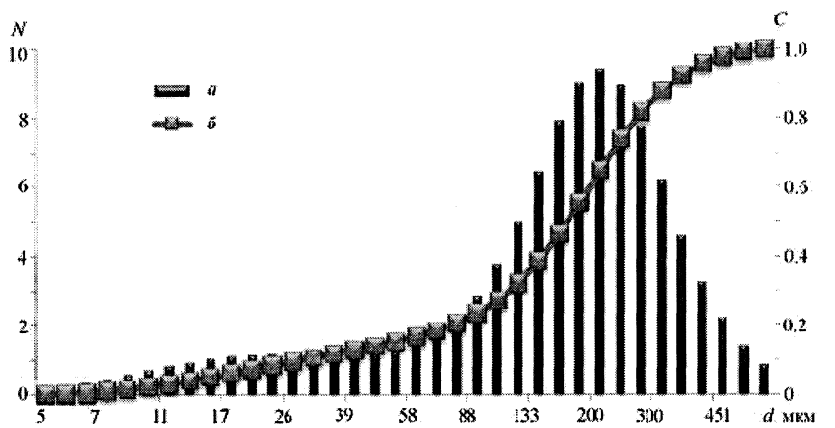

Figure 1. Lignin particles distribution by size: a –frequency of particle appearance in the field of view; b –relative quantity of the particle in the field of view. Journal of Engineering Physics and Thermophysics, 2012, v.85,N.3, 611-618.

Hydrolytic lignin with absolute density by helium 1,48 g/sm^3, bulk density 0,24-0.27 g/sm^3, ash content 12-17 %. pH of water extract 2,8-4,2 and Klason lignin content 53-69 % was under study after the modification for the hydrophobic properties. Its specific surface area by nitrogen was 3,7-7,2 m^2/g, total pore volume 4,5-16,5 mm^3/g, methylene blue sorption capacity 120-170 mg/g and oil products sorption capacity 2,2-4,0 g/g. In the comparison with other oil sorbents Lignosorb

has the lowest sorbent price and the lowest cost of the sorbent required for the sorption of a ton of crude oil. There are different sources of oil products waste in Belarus. They are granary burial of oil opened and closed types(0,5-1,0 mln tons); abandoned boiler rooms which worked on mazut; the remains of the motor, diesel, industrial oils which have lost their consumer properties; oil wastes after washing of mobile equipments, and trains; sludge of oil removers, petroleum separating plants, pipelines and cleaning of oil tanks.

The mixing of oil products waste and hydrolytic lignin with the following pressing was seemed for us as an appropriate move in the direction of the composite fuel pellets and granules production. The gross calorific values(GCV) of different types of the solid fuels are presented in Table 1. The GCV for the combined fuels is higher than for the traditional solid fuels including the pellets of the hydrophobic lignin (Lignosorb).

Table 1. The gross calorific values of different types of the solid fuels

Sample	Gross calorific value, MJ/kg
Lignosorb+ petroleum	38,8
Lignosorb + diesel petrol	32,3
Llignosorb+industrial oil	32,1
Lignosorb	22,7
Brown coal	10,515,7
Black coal	20,930,1
Anthracite	26,831,4

As follows from the data of Figure 2, the carbon content per the dry fuel mass without ash is higher in combined fuels than in wood. The reason is the removal of the part of hydrocarbons during the pyrolysis.

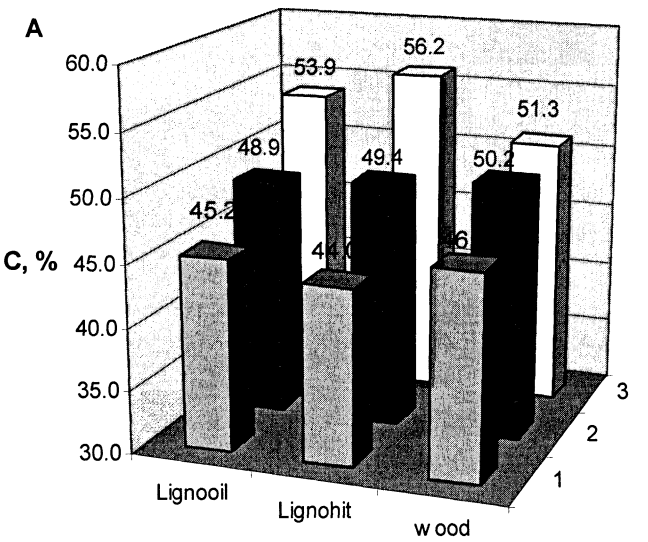

Figure 2. The diagram of the carbon content in the fuel granules in the calculation per the initial (1), dried (2) and dried ashless mass (3).

The process of burning of the fuel granules was conducted by the original device with the camera of the gasification and the camera of burning of volatile pyrolysis/gasification biomass products. The three stages of the process of burning: stage of inflammation, stage of stable burning and stage of smoldering have been investigated. It has been shown that the time of the inflammation of combined fuel is reduced with the including of the oil products into the composition of the granules. It is lower than the corresponding value of the wood. Stable burning stage time is

increased and the stage of smoldering is reduced. But the time of smoldering in the absolute values and in the percentage ratio exceeds the same one for wood (Table 2).

Table 2. Duration of the different stages of burning and the middle velocity of the mass loss at the burning of the fuel granules

Sample	Inflammation		Stable burning*		Smoldering*		Velocity of the mass loss, g/min **
	duration		duration		duration		
	seconds	% *	seconds	%*	seconds	%*	
Wood	256	15	1240	73	274	12	7,2
Lignochit (lignin)	687	31	1053	48	467	21	5,3
Lignooil (lignin +oil)	183	10	1224	69	362	21	6,0

**- percentages of the total duration of the process.*

***-per dried ashless mass of the fuel.*

The amount of CO_2 in the exhaust gases has been shown to reduce in Lignochit granules in the accordance with wood granules and Lignooil granules.

The results of the estimation of GCV, ash content and other characteristics for the combined fuel granules on the basis of hydrolytic lignin and real waste of the industrial oils are presented and discussed.

Owing to the high calorific value combined solid fuel on the basis of lignin and waste oil products are the perspective kinds of the solid fuels.