Research on the possibility of using pyrolysis products from energy willow and waste from MDF fibreboard

W. Ścierski[1], M. Kajda-Szcześniak[1], M. Landrat[1]

[1]Department of Technologies and Installations for Waste Management, Faculty of Energy and Environmental Engineering, The Silesian University of Technology, Konarskiego 18, 44-100 Gliwice, Poland
Keywords: pyrolysis, waste management, electricity production, fuel properties
Presenting author email: marcin.landrat@polsl.pl

With the increase in the number of green energy sources (mainly wind farms using wind turbines and solar power plants using photovoltaic panels), the problem of balancing power lines arises. This is related to the specificity of obtaining energy from renewable sources. The simplest way to say is that at certain times of the day there is too much energy produced, at others there is too little. This can be counteracted by using energy storage.

The authors proposed a non-obvious solution to this problem by using the low-temperature pyrolysis process to transform waste into useful substances. This process can be carried out during periods of excessive electricity production (and its use to heat the pyrolyzer charge). During periods of decline in electricity production, previously obtained pyrolysis gases and pyrolysis oil can be used for its production. This procedure will allow the use of many groups of waste having a certain energy potential [1,2,3,4,5,6,7,8]. However, this approach requires conducting numerous studies that will be able to demonstrate the validity of the adopted assumptions.

The aim of the research was to check the fuel properties of products from the low-temperature pyrolysis process of selected groups of waste.

The research stand and the course of the pyrolysis process were discussed by the authors in previous publications, e.g. [9]. There, the research methods used for individual products of the pyrolysis process were also discussed in detail.

The summary shows selected test and analysis results for two types of solid substances and three products of the pyrolysis process of these substances (pyrolysis gases were not subjected to detailed analysis). The substances discussed are presented in Table 1. The pyrolysis process was carried out at a temperature of 425ºC.

Table 2 shows the mass balance of the pyrolysis process for selected substances, and Table 3 shows the results of testing their physicochemical properties.

Table 1. The following nomenclature of the tested substrates and products was adopted in the article.

MDF	Waste furniture made of MDF fibreboard
EW	Energy willow chips
MDF_Char	Char from MDF fibreboard
EW_Char	Char from energy willow chips
MDF_Oil	Oil from MDF fibreboard
EW_Oil	Oil from energy willow chips
MDF_Oil_CW	Oil-Contaminated Water from MDF fibreboard
EW_Oil_CW	Oil-Contaminated Water from energy willow chips

Table 2. Masses of substrates and products (g).

Type of Waste	Input	Char	Pyrolytic Oil		Pyrolytic Gas
			Oil-Contaminated Water	Oil	
MDF furniture board	1000.00	418.00	192.14	31.86	358.00
Energy willow	1000.00	360.00	221.12	42.88	376.00

Table 3. Physicochemical properties of the substrates.

Parameter	Unit	MDF	EW
Total moisture	% mass	8.08	7.11
Combustible fraction	% dry mass	99.29	98.95
Ash	% dry mass	0.71	1.05
Volatile fraction	% dry mass	73.27	76.15

High Heating Value	MJ/kg dry mass	19.23	19.41
Low Heating Value	MJ/kg dry mass	18.26	17.79
Carbon	% dry mass	47.21	49.58
Hydrogen	% dry mass	3.35	6.39
Oxygen	% dry mass	35.11[a]	34.41[a]
Nitrogen	% dry mass	4.43	1.15
Sulphur	% dry mass	0.449	0.220
Chloride	% dry mass	0.67	0.08

[a] by difference

Table 4. presents the test results for the products of the pyrolysis process of the tested substances. In the case of oil-contaminated water, some determinations were not made and the mark - appears in the table.

Table 4. Physicochemical properties of the products

Parameter	Unit	MDF Char	EW Char	MDF Oil	EW Oil	MDF Oil CW	EW Oil CW
Total moisture	% mass	0.00	0.00	0.00	0.00	-	-
Combustible fraction	% dry mass	95.07	96.75	100.00	100.00	-	-
Ash	% dry mass	4.93	3.25	0.00	0.00	0.00	0.00
Volatile fraction	% dry mass	25.23	21.02	100.00	100.00	-	-
High Heating Value	MJ/kg dry mass	27.85	27.78	27.26	26.66	-	-
Low Heating Value	MJ/kg dry mass	27.02	26.81	25,49	24.96	-	-
Carbon	% dry mass	75.29	80.74	59.31	59.02	7.80	13.07
Hydrogen	% dry mass	3.80	4.44	8.18	7.78	8.45	9.83
Oxygen	% dry mass	8.14[a]	1.04[a]	30.23[a]	31.73[a]	80.42[a]	89.53[a]
Nitrogen	% dry mass	6.44	1.14	2.11	1.36	3.22	0.64
Sulphur	% dry mass	0.224	0.052	0.082	0.045	0.052	0.000
Chloride	% dry mass	1.18	0.08	0.09	0.07	0.06	0.00

[a] by difference

Analyzing the obtained results, it can be concluded that both char and pyrolysis oil can be used in thermal processes. This is indicated by high values for flammable parts, carbon, hydrogen content and calorific value.

Summarizing the research results, it is possible to propose a direction for further use of the obtained substances. Pyrolysis oil can be used as fuel to drive diesel generators, thus producing electricity during periods of energy shortage. The char can be used in the production of activated carbon, e.g. by activating it at high temperature. The proposed solutions are consistent with the assumptions of circular economy, both as its closure (electricity production) and the production of a new useful product - activated carbon.

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