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EVALUATION OF QUALITY OF OUTPUT PRODUCT IN THE TECHNOLOGY GROUP FOR PYROLISIS OF ORGANIC WASTE SUBSTANCES

ZHODNOCENÍ KVALITY VÝSTUPNÍHO PRODUKTU TECHNOLOGICKÉHO CELKU PRO PYROLÝZU ORGANICKÝCH ODPADNÍCH LÁTEK

Abstract

The issue of ecological removal of organic polymer materials and wastes polluting the environment is very much alive and it is clear that it will take on ever greater importance. a promising and innovative technology for environmentally friendly disposal of waste organic matter is pyrolysis. This method of thermal processing of waste for its degradation as well as a source of valuable energy products using the new system Pyromatic. This paper presents its technical description and evaluation of the quality of output product from the pyrolysis of tires, plastics and coal.

Abstrakt

Problematika ekologického odstraňování polymerních materiálů a odpadů znečišťujících životní prostředí je V současnosti velmi živá a je zřejmé, že bude nabývat na stále větší důležitosti. Perspektivní a inovativní technologií pro ekologickou likvidaci odpadních organických látek je pyrolýza. Tento způsob termického zpracování odpadů za účelem jejich degradace a zároveň zisku energeticky hodnotných produktů využívá nový systém Pyromatic. V příspěvku je předložen jeho technický popis a zhodnocení kvality výstupního produktu Z pyrolýzy pneumatik, plastů a uhlí.

1 DESCRIPTION OF TECHNOLOGY

Pyromatic is a fully automated modern power apparatus, which means the pyrolysis process of waste, occurs at a wide range between 50-150 $kg{\cdot}hod^{-1}$. These are mainly of waste rubber, selected components of municipal waste and the unused components of sorted waste. The unit consists of several sub-devices, allowing the whole technological process, namely transport of feedstock into the retort, heating without access to oxygen agent, resulting treatment of pyrolysis gas and removal of dry and liquid product.

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Supply of feed material is carried out by belt conveyor, which leads it into the hopper, from which it is transferred by a screw conveyor into the retort. When transferring material from the conveyor into the hopper the access of unwanted oxygen is minimal

For complete removal of all present air is then used an inert gas, which is blown through the inner part of the equipment.

In the basic module unit (worm retort) occurs the thermal decomposition of material for the current shift. Displacement is effected by screws - two primary and one secondary, which lead the material back into the entrance of the retort. The advantage of the retort auger is to ensure continuity and stability in operations, and good heat transmission in pyrolysed raw material.

During the process the feed material is heated above the thermal stability of the organic matter present. Consequent fragmentation of high-molecular strings into stable low-molecular products and solid waste, which is accumulated in the ash box at the end of the secondary screw. Pyrolysis takes place at a temperature of 500 °C to 800 °C and residence time of the material ranges from 45 min. to 1 hour.

The resulting pyrolysis gas is fed from the retort to the cyclone and then into into the air and water coolers. In the process of cooling the gas condenses some hydrocarbons in the liquid phase, whose properties depend mainly on the composition of the pyrolyzed material. After these adjustments to the gas it can accumulate in the gas tank or be directly used.

Heat for heating the material is supplied by indirect heating in the five gas burner sections, which are located behind the retort. Distribution of the burners along the length of the retort permits necessary regulation of the heat input into different sections depending on the temperature which has reached the pyrolysed material. As fuel gas or propane is used or at a higher flow rate natural gas. Maximum heat input of the furnace is 200 kW. The entire combustion process is captured in all sections by temperature sensors. Combustion air is fed into the various sections under the burner holes and can be regulated both through the input valve, or by flue gas fan speed.

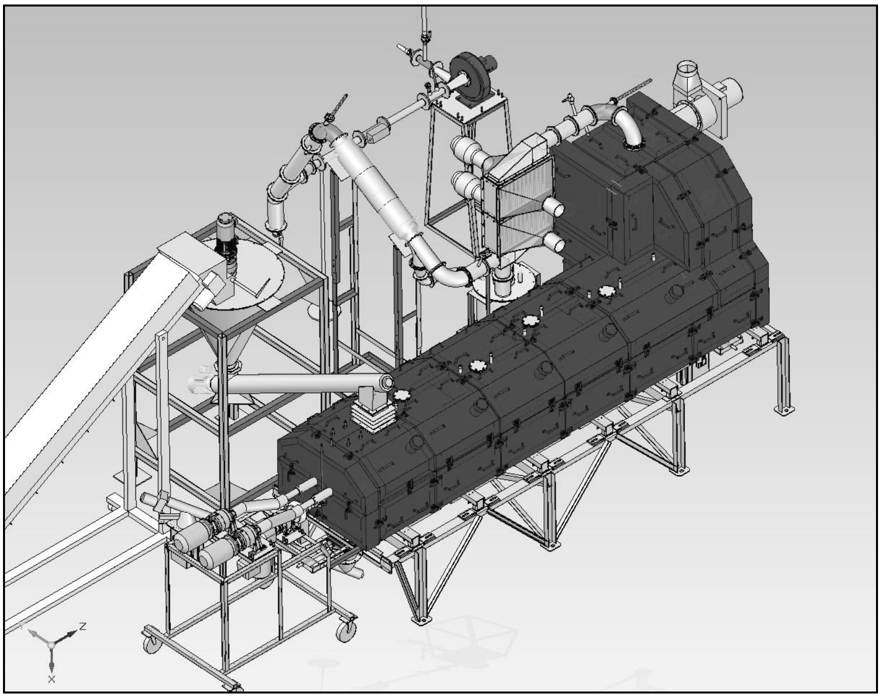

Fig. 1 Pyrolysis equipment Pyromatic.

2 OPERATION, TESTS AND MEASUREMENT

During operation, all parameters of the energy are captured in a number of measuring devices. Automatic two-position control is provided by maintaining the desired temperature. Management of the unit is executed from the control room and all values are automatically captured at intervals and stored in the database to be subsequently evaluated. Transducers are regularly calibrated by comparing them with external devices.

Composition of pyrolysis gas produced is measured by analyzers that determine the concentration of H_2, CH_4, CO, CO_2 and TOC (Total Organic Carbon).

Pyrolysis is tested under different conditions affecting chemical reactions during the process, and thus the quantity and quality of products. The purpose of tests and measurements is the determination of:

- conversion rate of materials to desired products,
- an ideal temperature range for the process,
- dependence in conversion of pyrolysis gas to composition and heating rate of the charge,
- the actual amount of heat needed to process.

Critical factors affecting the progress of the process, incl. quality of output products are:

- temperature and pressure in the retort,
- retention time of charge,
- composition, moisture content and grain size of the input material.

3 OUTPUT PRODUCTS

Were tested three types of materials (coal, plastics and tyres) at temperatures of 500, 600 and 700 °C. Analysis of these materials is presented in Table **1** (Laboratory of VSB - TUO). The portion of the raw material for one test was 60 kg and detention time was 45 min. Formed a working atmosphere of argon overpressure of approximately 250 Pa.

When testing different materials in virtually all was found that 50 to 75 % of the pyrolysis gas consists of CO, CO_2, H_2 and $\Sigma C_X H_Y$ in varying proportions (according to the process temperature and type of material).

Summary of measured values is presented in Tables and Figures **2** and **3.**

Tab. 1 Composition of tested materials.

	Representation of individual components in the material [%]						
Material	C	H	S	O	N	Humidity	Ash
Coal	54.0	7.0	< 0.1	16.6	0.8	18.1	3.6
Tyres	83.2	6.9	1.0	3.8	0.3	0.5	4.3
Plastic (PE)	85.4	14.4	-	0.2	< 0.1	-	-

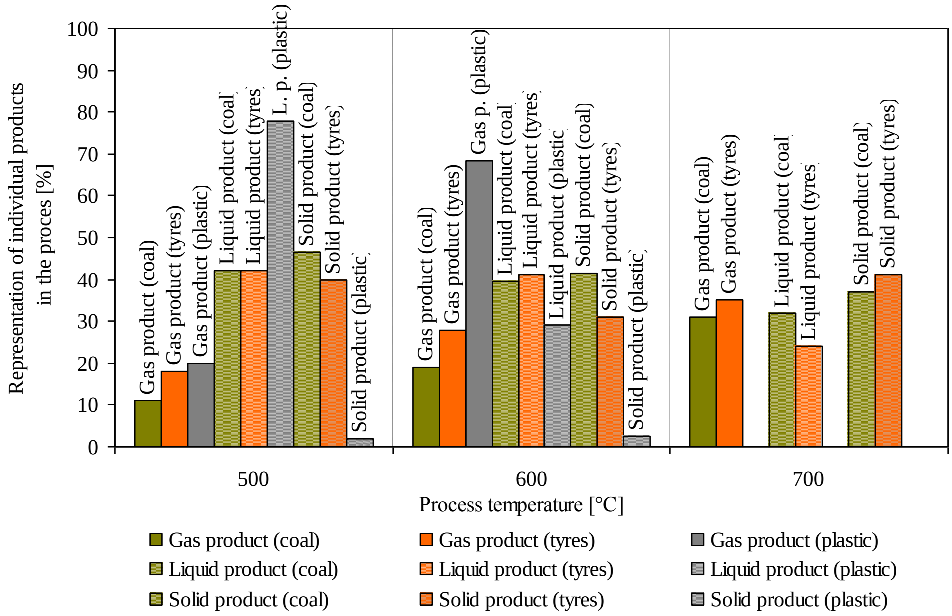

Fig. 2 Average representation of the different products depending on pyrolysis temperature and type of material.

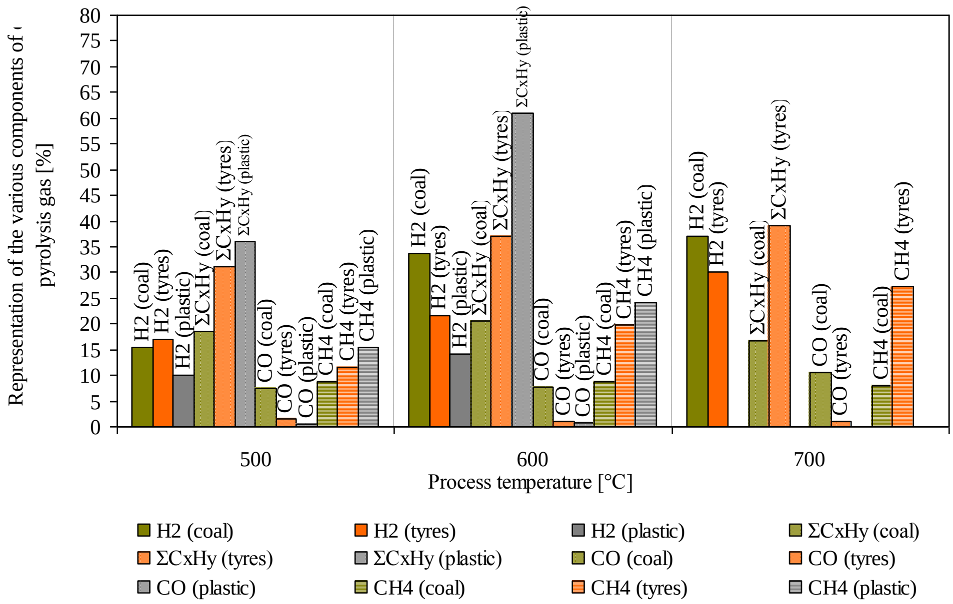

Fig. 3 Average composition of pyrolysis gas produced in the process depending on temperature and material specifics.

Tab. 2 Average representation of pyrolysis products with regard to the temperature of the process and material.

Material	Temperature [°C]	Average percentages of individual products [%]		
		gas	liquid	solid
Coal	500	11	42	47
	600	19	39.5	41.5
	700	31	32	37
Tyres	500	18	42	40
	600	28	41	31
	700	35	24	41
Plastic	500	20	78	2
	600	68.5	29	2.5

Tab. 3 Average composition of pyrolysis gas produced in the process depending on temperature and type of material.

Material	Temperature [°C]	Average composition of pyrolysis gas [%]				
		CO	CO_2	H_2	CH_4	$*\Sigma C_X H_Y$
Coal	500	7.5	14.7	15.4	8.8	18.6
	600	7.7	12.8	33.6	8.7	20.5
	700	10.6	10.9	37.0	8.0	16.8
Tyres	500	1.6	3.7	17.1	11.5	31.0
	600	1.0	1.6	21.6	19.9	37.0
	700	1.0	1.2	30.1	27.2	39.0
Plastic	500	0.5	2.1	10.0	15.3	36.0
	600	0.8	1.1	14.2	24.1	61.0

* incl. CH_4

4 CLOSINGS

In examining the pyrolysis of the tested materials was found to be the largest transfer of gaseous products is the plastic and at least the coal. With increasing temperature always the increasing proportion of gaseous products and solid part of the product shrinks (viz. Fig. **2**).

The most valuable gas arises from pyrolysis of plastic at temperature 600 °C and its average net calorific value is almost 45 $MJ \cdot m^{-3}_N$. Gas phase from pyrolysis of coal has the lowest value. Gas phase from pyrolysis of scrap tires, plastic and on one occasion also of coal (during pyrolysis at 500 °C) is composed from hydrocarbons, methane has the highest value of concentration. Amount of carbon monoxide and carbon dioxide is higher during pyrolysis of coal than during pyrolysis of scrap tyres and plastic.

Overall comparison of the quality and quantity of pyrolysis gas generated with regard to the set temperature and process material is in Table and Figure **4**.

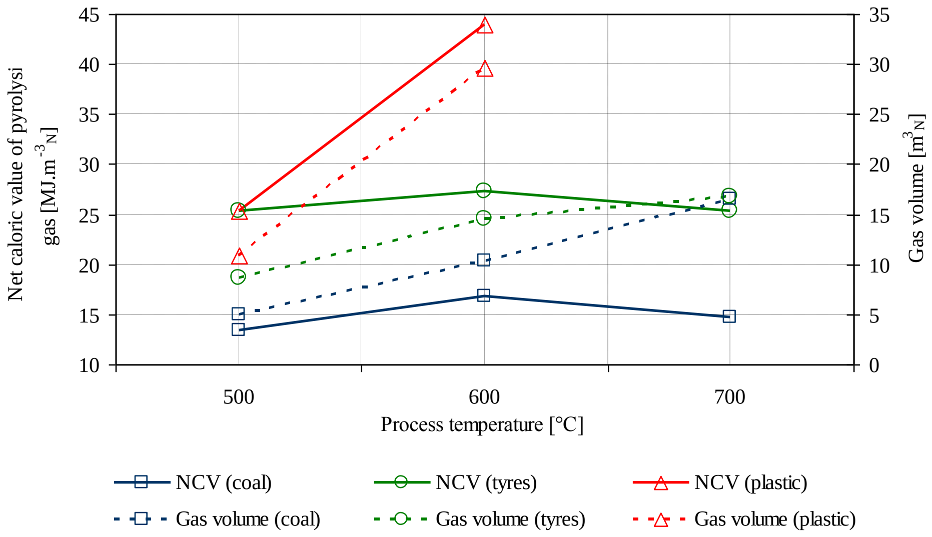

Fig. 4 Average net calorific value and yield of gas phase depending on temperature and kind of input material.

Tab. 4 Average quantity and quality of pyrolysis gas at different temperatures during the process of material retention, 45 min.

Material (60 kg)	Temperature [°C]	V_P [m^3]	$V_{P(NC)}$ [m^3_N]	NCV [$kJ.m^{-3}_N$]	GCV [$kJ.m^{-3}_N$]
Coal	500	5.8	5.0	13368	14646
	600	12.1	10.4	16841	18599
	700	19.2	16.5	14727	16311
Tyres	500	10.1	8.7	25276	27608
	600	17.0	14.6	27314	29956
	700	19.6	16.8	25306	27955
Plastic	500	12.7	10.9	25302	27632
	600	34.5	29.6	44006	48000

V_P – average amount of pyrolysis gas; $V_{P(NC)}$ – average amount of pyrolysis gas phase relative to normal conditions; NCV – average net calorific value of pyrolysis gas; GCV – average gross calorific value of pyrolysis gas

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